

Annual Report 2023-24



Birbal Sahni Institute of Palaeosciences

53 University Road, Lucknow 226 007, U.P., India

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



BSIP *at a glance*

Prof. Birbal Sahni, Fellow of Royal Society, London, and a legendary, founded the 'Institute of Palaeobotany' in the year 1946, with a vision to establish palaeobotany as a science in itself. He envisioned the use of fossil plants in understanding the origin and evolution of plant life, their role in resolving various geological problems and tremendous utility in fossil fuel exploration. To acknowledge his immense contribution in the field of palaeobotany, and offer a tribute to his legendary vision, the institute was named after him as Birbal Sahni Institute of Palaeobotany (now recognized as Birbal Sahni Institute of Palaeosciences). During the initial days, the mandate of the institute was to focus on studying the fundamental aspects of plant fossils across geological time span and their

allied aspects; later in the subsequent years, impetus was also given to understand the evolution of early life and studying climate and vegetation of recent past. However, to compete with the cutting-edge science of today, institute has widened its research dimensions and significantly expanded its mandate in the past decade. In the year 2017, it is rechristened as Birbal Sahni Institute of Palaeosciences, accommodating a more holistic approach with reinforced strategies to pursue palaeosciences under one roof and cater enhancing needs of the country amidst global change. The newly widened mandate aims to look at

- Understanding the origin and evolution of life through time
- Understanding climate change in recent and deep geological times
- Understanding past civilization and human history
- Application of palaeosciences to exploration programmes for the oil and coal industry

At BSIP, dedicated scientific teams are constantly endeavoring with indomitable spirit to attain excellence in R & D through their integrated innovative ideas in basic and applied research. The main thrust areas of research work involves unravel and interpret origin and evolution of primitive life, radiation and proliferation of Precambrian life; diversity, distribution, origin, evolution of Palaeozoic and Mesozoic flora, intra- and inter-basinal correlation during Gondwanan and Cenozoic time-slices and work on organic petrology to evaluate the quality of Gondwana coals and Cenozoic lignites for their economic utilization. BSIP has been continuously exploring and diversifying to include sequence biostratigraphy, magnetostratigraphy, and geochronology to help in the correlation of surface and subsurface sediments, geochemistry, vertebrate palaeontology, palaeogenomics and exploring areas favorable for fossil fuel deposits. Understanding the links between climate change and vegetation during the Quaternary Period is also an important part of research at the BSIP. For the pre-Quaternary studies, the concept of relative dating and biostratigraphy (with the help flora and fauna) are used with a coarse resolution of millions of years scale, but for the Quaternary dating BSIP is well equipped to give absolute ages at more finer resolutions (millennial scale). Scientists are also engaged in using real time data and study of tree-rings to deduce palaeomonsoon/climate in our recent past. For this, a mega pan-India project 'Lake Coring Project' is also being carried out. Origin and antiquity of ancient civilizations, human history and subsequent interventions are also being done using ancient DNA analysis. It is pertinent to mention that BSIP is working not only pan-India but also working in the Polar Regions (Arctic/Antarctic) as well. With latest state of the art facilities, it is one of those few premiere research institutes in the country, where state of the art facilities are available under one roof to facilitate high end research work. Institute is equipped with TL/OSL dating system, IRMS, ICP-MS, GC-MS, XRF, FTIR instruments and Clumped Isotope Laboratory for geochemical analyses, Palaeomagnetic Laboratory, Vertebrate Palaeontology and Preparation Laboratory, Ancient DNA laboratories, FE-SEM Laboratory, Confocal Laser and Raman Spectroscopy (CLSM) Laboratory, Amber research Laboratory, Advanced Coal Petro-Geochemical Laboratory and Industrial Micropalaeontology Laboratory. Institute also has a 'Centre for Promotion of Geoheritage and Geotourism' (CPGG) unit which is actively engaged in conserving and promoting the fossils sites across the country and also facilitates various outreach activities to spread awareness and knowledge about palaeoscience to the common people. In addition, the Museum of the Institute offers a rich repository of fossils and the Knowledge Resource Centre has a rich collection of literature on palaeosciences. The institute hosts national/international scientific meets from time to time, and also publishes catalogues, atlases, etc. as special issues, besides publishing a journal 'Journal of Palaeosciences' of international repute. The institute is presently functioning as an autonomous research organization under the aegis of the Department of Science and Technology (DST), Ministry of Science and Technology, Government of India.

Annual Report

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1946

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From the Director's desk



I am pleased to present the 2023-2024 Annual Report of the Birbal Sahni Institute of Palaeosciences. With the assumption of my role as the Director of BSIP, it has indeed been a year of new learnings, through various avenues for a deeper understanding about the ongoing and proposed research activities at the Birbal Sahni Institute of Palaeosciences. I consider it both my honour and privilege to lead BSIP as it aims to scale scientific excellence and glory.

With the change in the mandate of the Institute from Palaeobotany to Palaeosciences and with the subsequent establishment of sophisticated instrument(s) and development of analytical technique(s), there is a paradigm shift in research activities with a multidisciplinary approach which includes a variety of biotic and abiotic proxies, for a holistic understanding of the evolution of floras, faunas, climate, ecosystems at different temporal and spatial scales through time. Thereby expanding the vision of the founder, Late Prof. Birbal Sahni, a world renowned Palaeobotanist. Thus BSIP is now one of the best equipped institutes in the country for palaeoscience research.

The report highlights research and academic activities at BSIP for the period April 1, 2023 to March 31, 2024. The primary aim is to place on record the research published in the scientific journals, on-going research programs, Ph.D. degrees awarded and other scientific activities such as colloquia, conferences, lecture series, seminars, workshops and others, held at the Institute, along with the overall view of the Institute's organisation and facilities. In this context, I would like to commend the participation our staff have shown all throughout 2023-24 in terms of publishing targeted research papers with new insights, receipt of awards and grants from national and international funding agencies such as DST-SERB, MoES, ONGC, NCPOR, INQUA and various State agencies, consultancy services provided and MoUs signed with various organizations.

A total of 75 students are enrolled in across the Institute's diverse Ph.D. programmes. 14 students received their Ph.D. degrees and 07 students submitted their theses over the past one year. During the same period, 116 research papers were published in referred journals, most of them with high impact factors. Among other publications include papers presented during the conference proceedings, some book chapters and popular science articles. These publications display the rich variety of scientific works spanning Precambrian to the recent time.



In particular, we have made significant progress in taking science to the society through scientific outreach activities. To achieve this, we have initiated the Centre for Promotion of Geoheritage and Geotourism (CPGG-BSIP) aimed at creating awareness among the common man and sensitize local villagers. In continuation with those initiated last year, this year we visited National Dino Fossil Park in Bagh town, Dhar district, Madhya Pradesh to sensitize local villagers about fossilized dinosaur eggs and science behind Kakad Bherav's untold story. The relevance of our outreach is further supported by the co-operation extended by the Central and State government agencies and UNESCO besides media, to advance national and international cooperation in conservation of geoheritage sites. We are fully committed to this initiative as it stands as the primary measure to preserve geoheritage sites of our nation. Outreach activities were also conducted under the aegis of Jan Bhagidari, marking World Environment Day, World Wetland Day, National Science Day and Earth Science Week. Further, throughout the year BSIP opened its gates for students of various schools and colleges to visit the museum and laboratories. The Scientists and Museum Staff of BSIP briefed them regarding the significance of fossils and the state-of-the-art laboratories of the Institute, introducing and inculcating in the young minds a passion for the field of palaeosciences.

In addition to the regular meetings, our scientists broadened their engagement across their respective regions, by active participation in national and international conferences, workshops, symposia and seminars to showcase the scientific endeavours of the Institute. This has earned us the bid to host the 22nd prestigious International Union for Quaternary Research (INQUA) Congress for the first time at BSIP, Lucknow in 2027. BSIP has also won the bid for the first time to host the 40th Convention-cum-conference of Indian Association of Sedimentologists at BSIP, Lucknow in December 2024.

At the same time, we continue to pursue advances in instrumentation to augment multidisciplinary approaches in research, wherein procurement of the state-of-the-art Micro-Computed Tomography (Micro-CT) equipment, IRMS and a Gas bench Peripheral are in process. The state-of-the-art Laboratory for the Coal Quality Assessment has been successfully established this year and is catering to the hydrocarbon industry. To facilitate the installation of these instruments, establishment of new state-of-the-art laboratories are in full swing in the rapidly upcoming new building, which will also accommodate the increasing number of staff and research students.

The concerted efforts of the Committee on official languages (Hindi) for promotion of use of Hindi language in day-to-day official workings of BSIP is commendable and appreciated by the Home Ministry, Govt. of India.

The progress we have made this year in the field of palaeoscience research and the steps we have taken to deliver our innovation strategy and to respond to the new challenges we face are incredible. Looking back at these achievements over the past year, I must warmly thank our scientific, technical and administrative staff of the Institute for their hard work and constant support.

I express my deep sense of gratitude to the Department of Science technology (DST), Government of India, Governing Body of the Institute and the Research Advisory Council (RAC) for their undeterred support and cooperation which is paramount for the progress of the Institute.

Mahesh G. Thakkar

(Director)



Organizational Highlights

- During the F.Y. 2023-24, BSIP scientists have published 158 research articles/book chapters in journals/books of international repute with a cumulative impact factor of 309.99.
- A total of 26 extramural projects sponsored by various national and international agencies such as ANRF (erstwhile SERB), MoES, ONGC, OIL, INQUA, Directorate of Archaeology and Museums (Govt. of Gujarat), Divisional Forest Department (Govt. of Bihar), University of the West of England (UWE) Bristol (United Kingdom) have been implemented/ongoing by BSIP scientists.
- In terms of research manpower trained, BSIP scientists provided training to 95 graduate/post-graduates and 14 Ph.D(s) were awarded during the F.Y. 2023-2024.
- The BSIP established a 'Science Club' on the 20th December 2023 under the banner of the Academy of Scientific and Innovative Research (AcSIR) for research students to encourage scientific communication and social adaptability.
- BSIP scientists participated in the Indo-German Science & Technology (IGSTC) Outreach Event at Lucknow on the 18th April, 2023.
- A Centre for Promotion of Geoheritage and Geotourism (CPGG) was established at BSIP on the 28th June 2023. The aim of the CPGG is to meet the 2030 Agenda of the UNESCO Sustainable Development Goals. In this regard, an MoU between Madhya Pradesh Ecotourism Development Board, Forest Department, Bhopal and BSIP, Lucknow was signed on the 25th July 2023. The CPGG also organised the "Earth Science Week-2023" from 8th to 14th October 2023 in the BSIP.
- A cleanliness campaign was conducted in the institute's premises under the 'Swachhta Action Plan' of GoI from 1st to 15th May, 2023.
- संसदीय राजभाषा समिति ने 22 जून 2023 एवं 23 नवंबर, 2023 लखनऊ में बीरबल साहनी पुराविज्ञान संस्थान के साथ निरीक्षण बैठक की, और संस्थान में हो रहे राजभाषा हिंदी के कार्यों का अवलोकन किया |
- Professor Mahesh G. Thakkar joined as the 'Director' of the Birbal Sahni Institute of Palaeosciences, Lucknow on 4th September 2023 after the superannuation of Dr. Vandana Prasad.
- The Institute's 'Foundation Day' was celebrated on the 10th September 2023. During the event, Professor Nitin R. Karmalkar (Chairman, Governing Body, BSIP) delivered a lecture on the topic "Flood Basalts - A Journey through the Deccan".
- As part of the "Azadi Ka Amrit Mahotsav" a series of STEMM podcasts, supported and catalyzed by the National Council for Science and Technology Communication (NCSTC, GoI) were recorded by BSIP scientists on 5th September 2023 and aired on 12th October 2023 (available on Spotify and weblink: www.i-radiolive.com) to popularise STEMM subjects in the society.
- हिंदी पखवाड़ा समारोह (14th to 24th September, 2024): हिंदी पखवाड़ा के उद्घाटन समारोह में प्रो. ध्रुव सेन सिंह ने 'जलवायु परिवर्तन: प्राकृतिक या मानव जनित?' पर व्याख्यान दिया। साथ ही BSIP में टंकण, टिप्पण, अनुवाद प्रतियोगिता में BSIP के कर्मचारियों व शोधार्थियों ने प्रतिभागिता की और अपनी राजभाषा के प्रति अपना समर्पण दिखाया।
- Tree plantation program under Swachhta Pakhwada – 2023 (from 15th September to 2nd October, 2023) was successfully organised in the premises of BSIP on 2nd October, 2023. In addition, under the GoI national initiative themed "Ek Tareekh, Ek Ghanta, Ek Saath", all members of the BSIP dedicated 1 hour of Shramdaan on the 1st October, 2023.



- BSIP celebrated its Founder's Day on 14th November, 2023. On this occasion, the 53rd Birbal Sahni Memorial Lecture was delivered by Professor Ashok Sahni (Emeritus Scientist, Panjab University) on "India on Collision course: A journey that changed the Planet" and the 65th Sir Albert Charles Seward Memorial Lecture was delivered by Professor Dhruv Sen Singh (Head, Department of Geology, Lucknow University).
- An "Amber Analysis and Palaeo-entomology Laboratory" was inaugurated on 14th November, 2023 in the Institute by Professor Ashok Sahni (Emeritus Scientist, Panjab University).
- The association of Quaternary Researchers (AOQR) celebrated its fourth 'Foundation Day' on 12th December, 2023. Professor Laura Sadori (President, INQUA) graced the occasion as a 'Chief Guest' and delivered a talk on the topic "*Southern European Quaternary pollen records*".
- The Vol. 72(1) and Vol. 72(2) of the BSIPs In-House 'Journal of Palaeosciences' were published in July 2023 and December 2023, respectively.
- BSIP participated and won the bid to host the prestigious 40th Convention-cum-Conference of the Indian Association of Sedimentologists that will be held in December 2024.
- The 'International Yoga Day - 2023' was celebrated on 21st June, 2023 in the Institute's premises. The program was kept as a 'Zero-waste' event to contribute towards reduction of carbon footprint to the environment following 'One Earth, One Family, One Future' theme of the International Yoga Day - 2023.
- A curtain raiser ceremony of the India International Science Festival (IISF) - 2023 was held on 29th December 2023 at BSIP under the theme "Science and Technology Public Outreach in Amrit Kaal". The BSIP participated and showcased good scientific practices and unique fossil collections in "Bhartiya Vigyan Sammelan 2023" held from 21st to 24th December 2023 in Ahmedabad, Gujarat as well as in the India International Science Festival held from 17th to 20th January 2024 in Faridabad, Haryana. The stall was visited by many dignitaries and students from various schools and colleges of the region.
- The first South Asian Biodiversity Council (SABDC) Meeting (online mode) was held by BSIP on 2nd February 2024.
- Dr Shilpa Pandey (Scientist, BSIP) was elected as Vice-President of Coastal and Marine Processes (CMP), International Union for Quaternary Association (INQUA) for the period of 2023-2027 and also empaneled as an Expert on Wetlands in the Chhattisgarh State Wetland Authority for the period of 2023-2025.
- Dr. Gaurav Srivastava (Scientist, BSIP) has become a "Member" of the Editorial Board of the journal Global and Planetary Change (GPC).
- The institute has placed an order for state-of-the-art Micro-Computed Tomography (Micro-CT) equipment as part of developing a Micro-CT National facility at BSIP.
- The institute is in the process of developing a state-of-the-art AMS National facility.



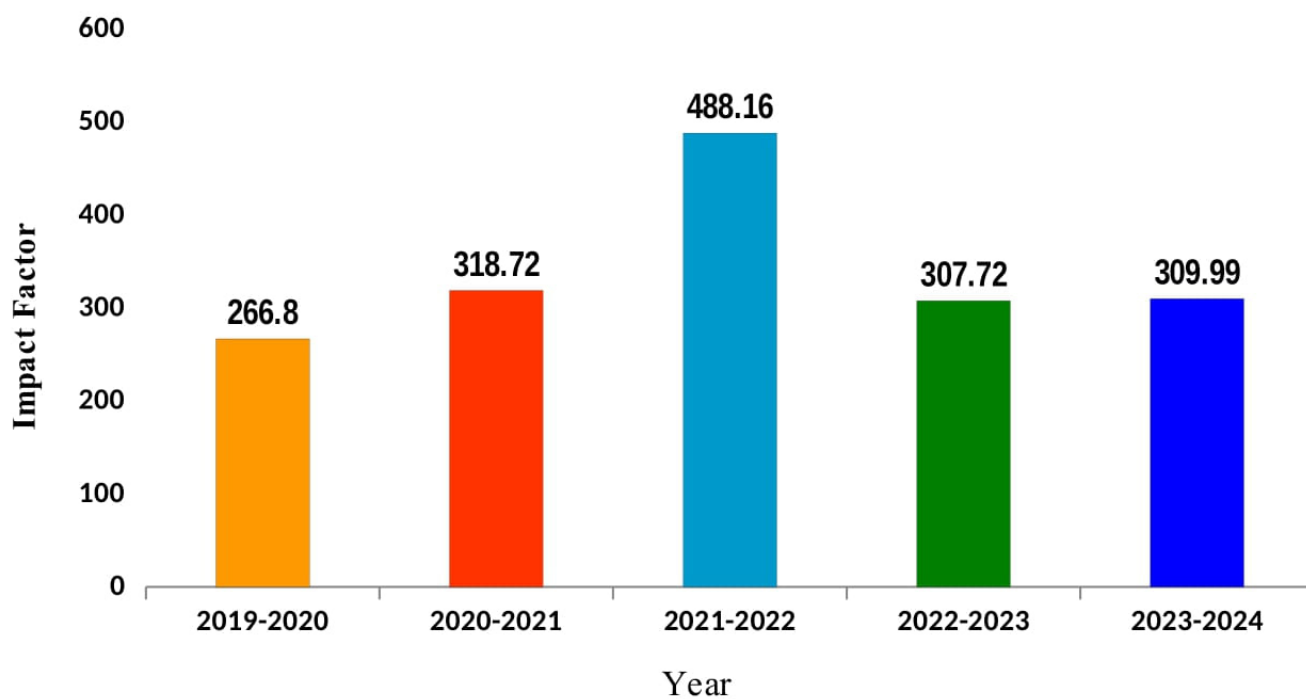
Research Highlights

- Assessment of the origin of two unusual morphotypes (resulted from the movement of amoeba-like organisms) from the 1.6 Ga old Chorhat Sandstone, Vindhyan Supergroup, raise questions about the Precambrian biotic structures (1.8–0.8 Ga) and the consensus prevailing regarding the appearance of motile life during the Ediacaran.
- Geochemical? studies revealed that the late Neoproterozoic Sirbu Shale (part of the Vindhyan Supergroup) was formed in a hydrographically restricted open marine shelf environment characterised by intense upwelling, resulting in high primary productivity.
- Highly diversified megafloral assemblages (13 genera and 72 species) of order Glossopteridales, Cordaitales and Equisetales were documented from the Barakar and the Raniganj formations within the South Karanpura Basin. The palaeofloral entities and geochemical parameters suggest that the Permian climate was cooler in initial phase, and subsequently became warm temperate and humid.
- An investigation on the origin of soft-sediment deformation structures (SSDS) and its implications on palaeoceanography and sediment architecture demonstrate the importance of sedimentological analysis to distinguish the seismite and its implications on palaeogeographic evolution and sedimentary architecture.
- An information system ‘The Indian Permian Seed Database (IPSD)’ for ensuring the digital storage, safety, accessibility and recovery of the details of Indian Permian seed records in a selective manner has been developed by BSIP. The database presently includes 28 genera and 44 species of compressed seeds described from Lower Gondwana (Permian), with all the details for access to researchers/academicians. <http://14.139.63.228.9092/SeedDatabase>.
- Fossil pollen form–species of four palm subfamilies: Arecoideae, Calamoideae, Coryphoideae and Nypoideae from the early Paleogene of India suggested that the Indian Plate served as an evolutionary hotspot for the diversification of palms during the early Paleogene and favoured the “Out-of-India” dispersal hypothesis for the Asian palms.
- Danian to Ypresian age was proposed for the lignite-associated sedimentary succession at Sonari Lignite Mine (Barmer Basin, Rajasthan State, western India). The investigation also led to identification of two vertebrate (dominantly fish-yielding) sedimentary units within the studied succession and argued that the deposition of the lignitic sequences along India’s western margin was not coeval. The study also argued in favour of the earliest appearance of dinoflagellate cyst Apectodinium in the near-equatorial region of the Tethys Ocean during the early Paleocene (within Danian).
- New diatom productivity record from the Sub-Antarctic Zone (SAZ) of the western Indian sector of the Southern Ocean (SO) suggests that the diatom productivity changes in the region were disconnected from dust flux changes, but might relate to frontal migrations and SO upwelling intensity changes which have both mediated the silica and iron availability for diatoms.
- Higher organic matter preservation and biological productivity observed in the Arabian Sea (AS) during the summer are due to strong southwest monsoonal winds. The sediment records from the AS also show similarities with the North Atlantic and Greenland mainly during Heinrich events (HEs) which is related to the atmospheric and oceanic tele-connections of the AS with the higher latitude climate perturbations.
- Dendrochronological studies showed more drought stress to deodar trees growing in monsoon areas in mid-and low-latitude sites where less snow melts and low precipitation during the spring season are predicted to increase evapotranspiration. This shows global warming is likely to become one of the significant drivers of forest losses in the Hindu-Kush Himalaya (HKH) during the 21st Century. The study recommends installation of early warning systems along with the siphoning of the lake using available engineering techniques to mitigate the damage to life and property.

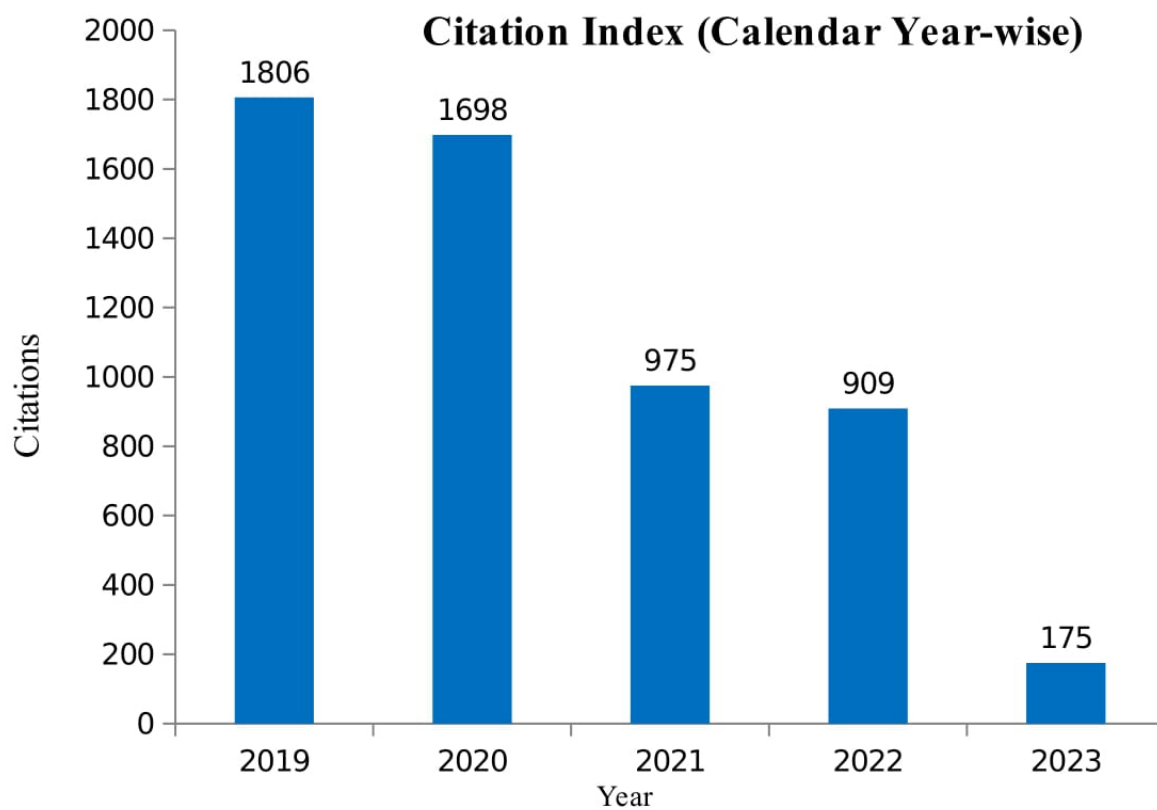


- Tree-ring based oxygen and hydrogen isotope ratios ($\delta^{18}\text{O}$ and $\delta^2\text{H}$) of Himalayan silver fir (*Abies pindrow*) from the south-eastern region of Kashmir valley facilitated reconstruction of precipitation of the previous year (December through the current year August) for the time period 1671-2015 which shows recent drying trend in the region.
- Reconstruction of palaeoclimate from sediments of a 7.65 m long core from the Khajjiar Lake, Himachal Pradesh, a climatically sensitive region affected by both ISM (Indian Summer Monsoon) and IWM (Indian Winter Monsoon) suggest two major climatic phases corresponding with the 4.2 ka and Roman Warm Period (RWP).
- Ensemble modelling approach to predict the distribution of *Diospyros melanoxylon* under present, past (Last Glacial Maximum, ~22,000 calyr BP, Middle Holocene ~6000 calyr BP) and future climate change scenarios (RCP 2.6 and 8.5 for 2050s and 2070s) helped in identifying parts of the country which would be severely affected by future climate change scenarios and plan conservation strategies for this commercially important species to facilitate its growth in suitable habitats which are likely to sustain under future climatic conditions.
- Isotopic and phytolith data provide agricultural evidence during periods of dynastic transitions in the urban site of Vadnagar (Gujarat), in semi-arid northwest India during the Late Holocene, a clear signal of changing local environmental conditions over two millennia, consistent with regional palaeoclimate records.
- Modern analog produced for pollen and non-pollen palynomorphs (NPPs) preserved in soil in relation to the different vegetation types and herbivore impact in the Kaziranga National Park (KNP) reflect both the extant vegetation types in each habitat as well as land use. Some site-by-site variation was observed with respect to the coprophilous fungal spores present in the palynoassemblage.
- High-resolution fine-grained genetic study of the Sinhalese population based on allele-frequency analysis showed a tight cluster of Sinhalese and Tamil populations, suggesting strong gene flow beyond the boundary of ethnicity and language. Interestingly, the haplotype-based analysis preserved a trace of the North Indian affiliation to the Sinhalese population. Overall, in the South Asian context, the Sri Lankan ethnic groups were found to be genetically more homogeneous than others.
- The nature of organic biomarkers found in subaerial 'Rock Varnish' in the extreme conditions of Ladakh region, north India, resulting from the mineral-microbial interactions suggests the potential role of varnish formation in the biogeochemical cycling of Mn and Fe, as well as the potential use of varnish as a biomarker for past microbial activity on Earth and other planets.
- United Nations protection programmes under the UNESCO's Global Geopark initiatives have resulted in the establishment and recognition of 195 Global Geoparks in 48 countries (except India) to sustainably protect Geoheritage. Nevertheless, India provides a diverse range of geoheritage in terms of rock records from the Precambrian to the Holocene. Owing to its unique Geoheritage and geotourism potential, a case to propose Palasava locale as a "geosite" within the "Kachchh Geopark" was put forth via a published article so as to protect and conserve this geologically significant locale, to enhance sustainable geotourism in the region for the economic benefit of the local population and for the interest of the public.

Cumulative Impact Factor - 2019-2024



Citation Index (Calendar Year-wise)





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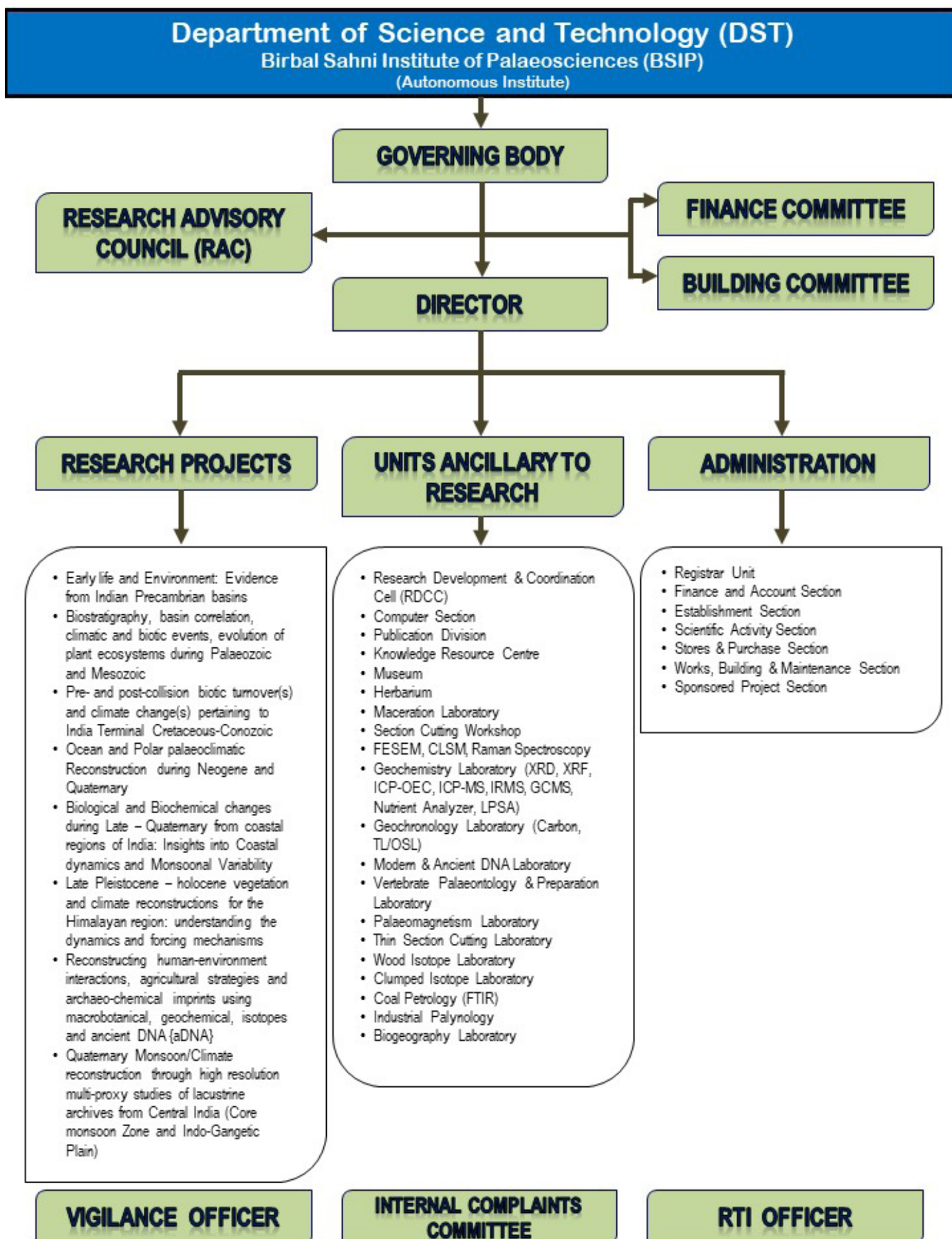
INDUSTRIAL PALYNOLOGY

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ORGANIZATIONAL STRUCTURE



RESEARCH

Project 1: Early life and environment: Evidence from Indian Precambrian basins

COORDINATOR: VEERU KANT SINGH (SCIENTIST E)

CO-COORDINATOR: SANTOSH K. PANDEY (SCIENTIST D)

OBJECTIVES

- *Tracing the antiquity of various life forms.*
- *To trace the emergence of photosynthetic oxygenation and subsequent changes in ocean redox structure.*
- *To understand the role of operative processes and depositional environment in the associated sedimentary formations.*
- *Study of life forms and associated biogeochemical processes in the extreme environment from the Archaean and Modern analogues.*

PREAMBLE

The major questions of the Precambrian palaeobiology are examined in the Indian Precambrian successions, including the origin and evolution of early life, the emergence of eukaryotes, or multicellular organisms, and their progression into complex metaphytes and metazoan forms along with evolution of oxygen. Stromatolites and microbially induced sedimentary structures from the Dharwar Craton in India date back to the Archaean Period (4000–2500 Million years); stromatolitic and non-stromatolitic layers of the Palaeoproterozoic Bajna Dolomite, Bijawar Group are studied to establish the syngeneity of preserved organic remains. Microscopic and megascopic fossil remnants from the Bhander Group

of the Vindhyan Supergroup in central India and the Raipur Group of Chhattisgarh are examined to determine their age, antiquity, and affinity. Strong geochemical investigations (Trace Elements, REE, TOC, and carbon isotope, and where possible, sulphur isotope) have been conducted to study the evolution of oxygen over the Proterozoic (2500–538 Million years ago) and its involvement in eukaryotic diversification. High primary productivity in an Ediacaran shallow marine basin influenced by strong seasonal to perennial upwelling is encountered in the Vindhyan Basin. A new fossil assemblage recovered from the youngest horizon confirms the Vindhyan Basin stopped depositing around 550 Million years ago. Sediments of the Cuddappah and Vindhyan Supergroup are investigated to understand how oxygen evolved during the Proterozoic and its involvement in eukaryotic evolution. Additional studies on the microstromatolites collected from hot spring sites in the Ladakh region have also been performed to understand the life forms and associated biogeochemical processes in the extreme environment from the Modern analogues.

PERSONNEL INVOLVED

Team Members: Arif Husain Ansari (Scientist D), Yogmaya Shukla (Scientist C), Arvind Kumar Singh (Scientist C), Gurumurthy G.P. (Scientist C)

Technical Support Member: Shivalee Srivastava (Technical Assistant B), Archana Sonker (Technical Assistant A)

CSIR-Pool Officer / Research Associate: Shamim Ahmad, Bandana Shukla



1st Row (L-R): Shamim Ahmad, Abhinav Jain, Md. Arif Ansari, Veeru Kant Singh, Santosh Kumar Pandey, Yogmaya Shukla, Archana Singh, Divya Singh. **2nd Row (L-R):** Arunaditya Das, Arvind Kumar Singh, Arif Husain Ansari, Kumail Ahmad, Faizan Ahmad Khan, Gurumurthy G.P.

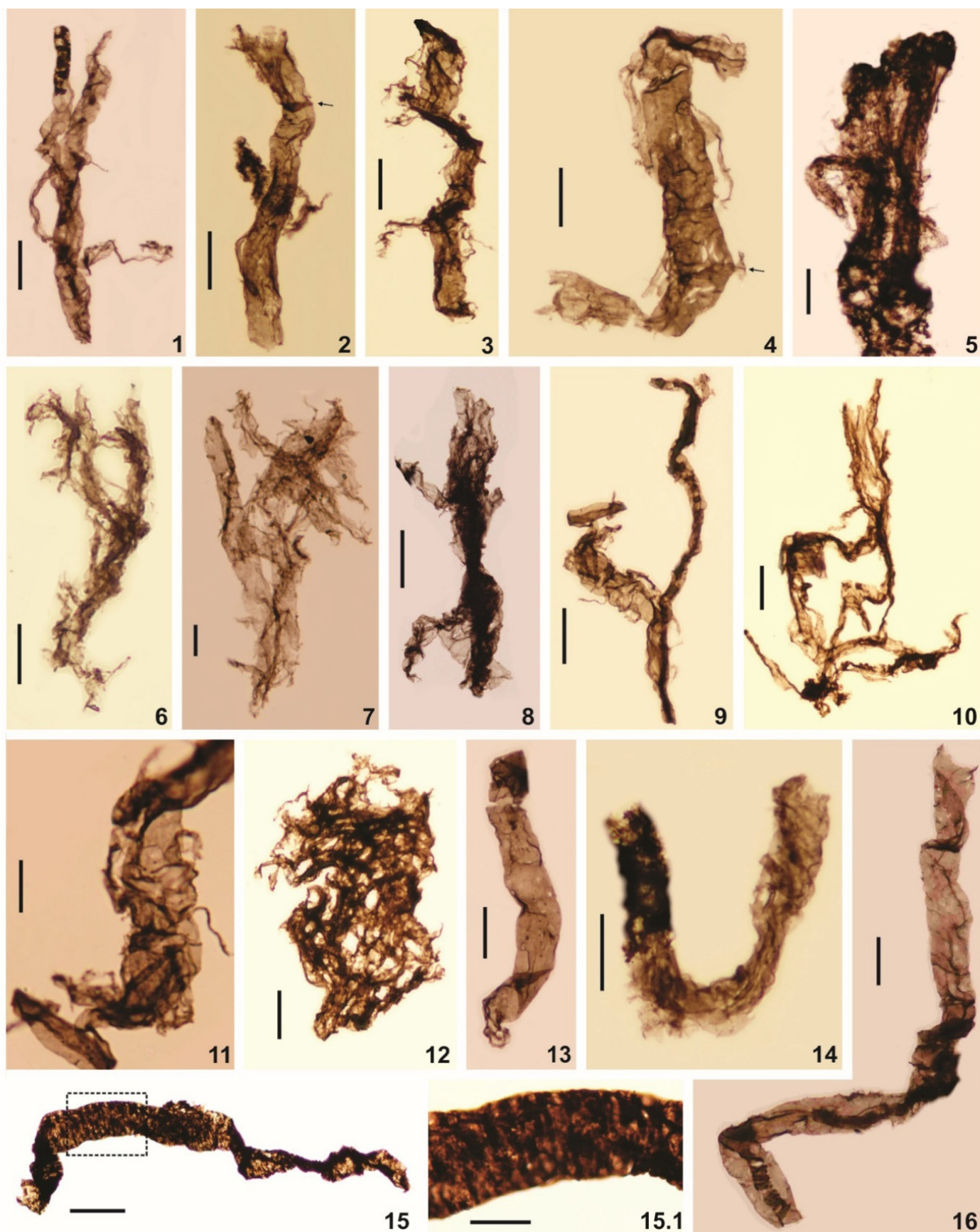


Fig. 1 - Tubular microfossils from the Raipur Group, Chhattisgarh Supergroup. 1, 7, 8- *Valkyria borealis*; 2, 4, 5- *Proterocladus major*; 3, 9- *Proterocladus minor*; 6, 10- *Pseudodendron anteridium*. Scale bar = 25 μ m each.

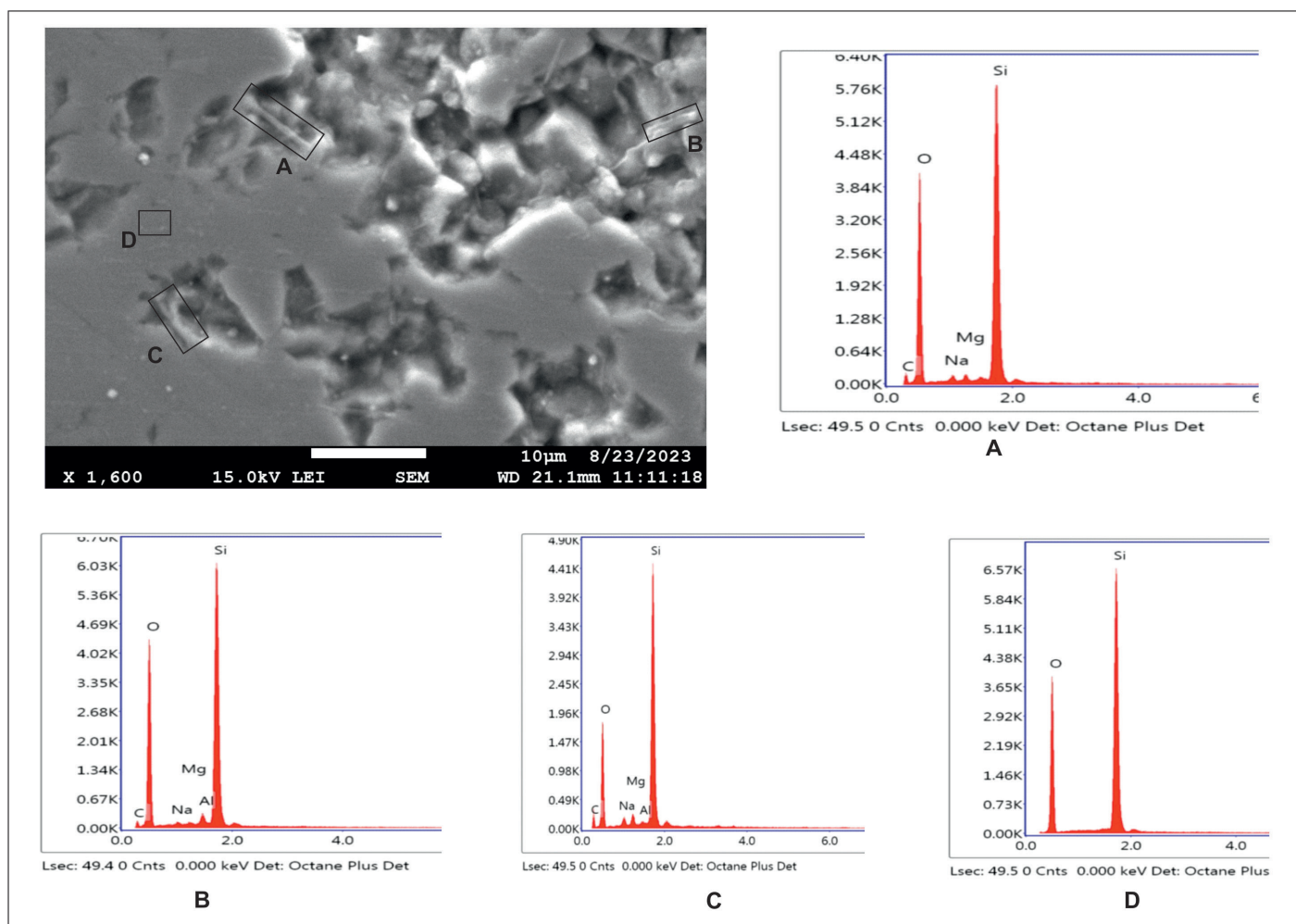


Fig. 2 - The figure shows the filament-like structures embedded in the matrix observed in FESEM. The graphs A, B, C, and D show the elemental composition of each point marked on the image.

Research Scholars: Abhinav Jain, Divya Singh, Kumail Ahmad, Faizan Ahmad Khan, Archana Sonker, Md. Arif Ansari, Arunaditya Das, Yogesh Kumar

SIGNIFICANT FINDINGS

Palaeobiological studies were carried out on the different stratigraphic units of the Chhattisgarh Supergroup to understand the origin, evolution and diversity of early eukaryotes in the Proterozoic (2500-538 Ma) biosphere. Carbonaceous black shale and silicified black cherts from the carbonate sequence of the Neoproterozoic Raipur Group were processed and recovered distinct Tonian age tubular organic-walled microbiota, viz. *Valkyria borealis*, *Proterocladus* cf. *P. minor*, *P. major*; *Pseudodendron anteridium*; *Pellicularia tenera*, *Rugosopsis tenuis* and *Polytrichoides lineatus* (Fig. 1). Besides, the well-preserved population of *Proterocladus* includes thin-walled, uniseriate and branched tubular filaments (140-216 µm) with pronounced intercellular constricted septa. Distinct septation and branching in the *Proterocladus*

show the multicellular grade of organization. Further, the *Proterocladus* are demonstrated as green seaweed by their size and complex multicellularity.

To know increased marine primary productivity in late Neoproterozoic Sea, the Sirbu Shale, Vindhyan Supergroup has been studied for trace elements, organic carbon isotopes and total organic carbon (TOC). The Cd enrichment in the Sirbu Shale samples is comparable to that in modern marine sediments of the oxygen minimum zones (OMZ) in Chilean margins, Arabian Sea and Gulf of California characterized by high primary productivity and seasonal upwelling. Based on Cd enrichment, it is inferred that the lower Sirbu Shale was deposited under suboxic conditions, while the upper ones under a relatively less reducing conditions. Cd/Mo ratios > 0.36 in the shale sample indicate that the palaeoproductivity was strongly influenced by the nutrient supply through sea-shelf upwelling. The TOC exported to the floor of Sirbu Shale palaeo-depositional setting through primary productivity ranged from 0.71 to 10.16%, using non-detrital enrichment of Cd in Sirbu Shale samples.

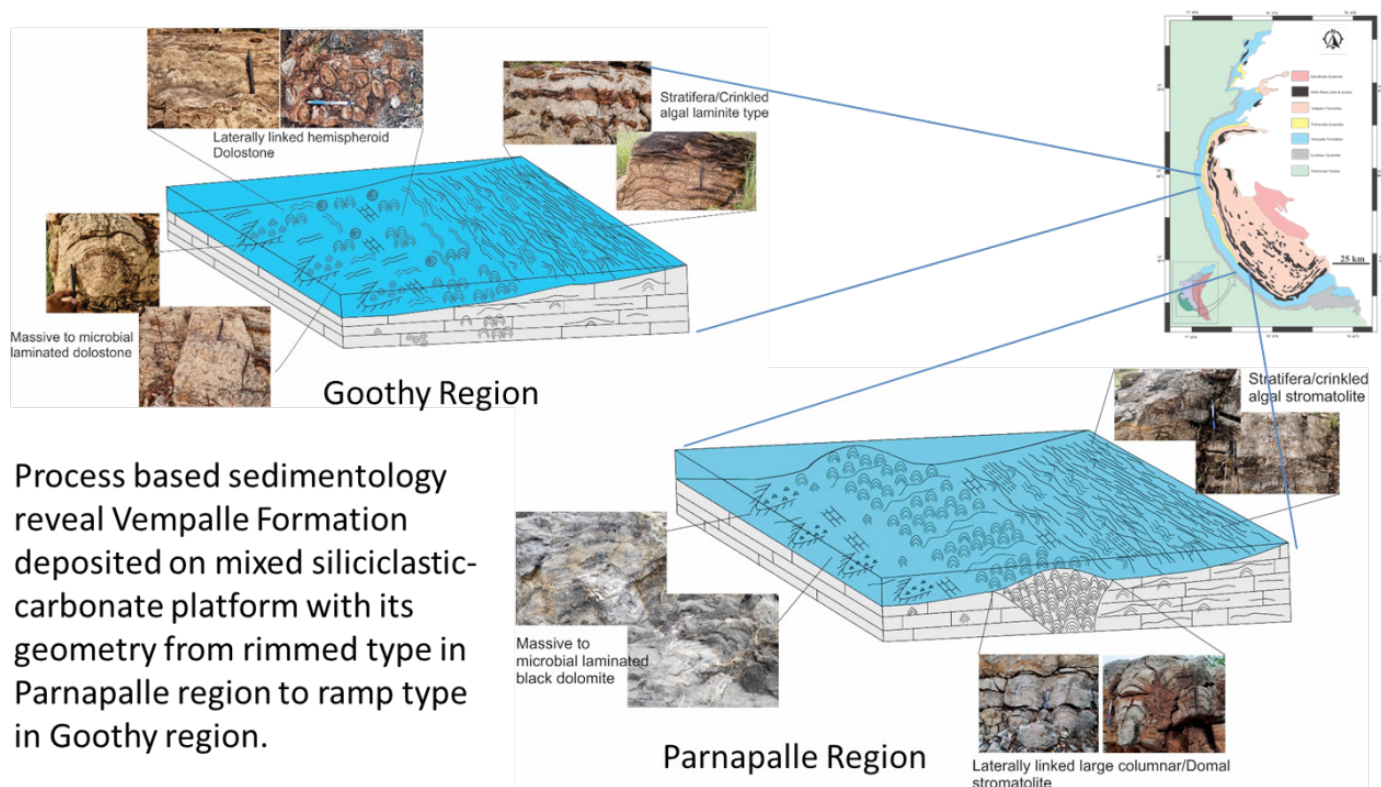


Fig. 3 - Schematic block diagram depicting laterally hybrid carbonate platform model during Vempalle sedimentation with development of rimmed carbonate platform in parnapalle region that gradually flattens northward in Goothy region showing ramp like geometry during lower Cuddapah sea.

Integrated petrography, SEM, and Raman Spectroscopy study of graphitised amorphous carbonaceous matters preserved in cherty black stromatolitic and non-stromatolitic layers of the Palaeoproterozoic Bajna Dolomite, Bijawar Group were conducted. This reveals that the carbonaceous matter is biogenic and syngenetic in origin, and is mainly the remains of extracellular polymeric substance secreting bacteria. Thin section slide petrographic analysis reveals that the carbonate reef is mostly made of dolomite, with alternating laminae rich in carbonaceous material in association with early diagenetic silica deposition (chalcedony). The carbonaceous matter is present in the form of sheaths and fragments dispersed in a three-dimensional orientation. This work demonstrates that it is possible to reliably analyse the biogenicity of carbonaceous matter in deep-time deposits using the combination of non-destructive methods as employed in this study.

The Donimalai Banded Iron Formation (BIFs), Sandur Schist Belt, Dharwar Craton is investigated to document Microbially Induced Sedimentary Structures (MISS) and Microbially Induced Sedimentary Textures (MIST) to establish the syngenecity of preserved organic remains, and the potential role of microbes in the formation of BIFs. The Field Emission Scanning Electron Microscope-Energy Dispersive X-ray analysis, and Raman Spectroscopy confirm the presence of syngenetic microbial mat

textures in the BIF, suggesting their connection with a microbially mediated oxidation and deposition of Fe in the predominantly anoxic Neoproterozoic Ocean, thus advocating for the biological origin of these rocks (Fig. 2).

A study was undertaken to investigate indicators of ancient productivity within the Buxa Formation of the Lesser Himalaya in Sikkim. By analyzing the isotopic values ($\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values) as well as Rare Earth Element (REE) composition, a total number of 151 carbonate samples were investigated across three sections of the Buxa Formation: Jorethang to Mangalbare, Legship to Naya Bazar, and Reshi to Mangalbare, Sikkim. The findings show that there was minimal variation in $\delta^{13}\text{C}$ values, consistently ranging between -0.5 and +2.5 ‰ VPDB. This pattern suggests a relatively steady and moderately high level of productivity during that time. This productivity might have been influenced by a temporary increase in atmospheric oxygen levels. Additionally, we have also reviewed and examined stromatolites as a part of the investigation.

Sedimentological investigation and facies association analysis of Vempalle Formation exposed in strike length of two laterally distinct regions, viz. Parnapalle and Goothy regions have been attempted to understand sediment dynamics and shelf palaeogeography of Lower Cuddapah Basin (Fig. 3). Eight facies associations recorded from Parnapalle region represent four different palaeogeographic

settings namely (a) Intertidal to shallow subtidal, (b) Shallow to deep subtidal, (c) Peritidal reef complex and (d) Back-reef lagoon associations whereas seven facies associations from Goothy region represent three distinctive palaeogeographic settings, viz. (a) Intertidal to Supratidal, (b) Intertidal setting and (c) Shallow subtidal settings. Correlation of these facies associations from both the regions reveal the establishment of hybrid carbonate platform during Vempalle deposition with the development of a rimmed carbonate platform in Parnapalle region that gradually flattens northward in Goothy region forming ramp like geometry thus, changing the significant facies characteristics and sediment dynamics of Lower Cuddapah shelf.

The Cuddapah Basin is characterized by quartzite-carbonate-shale cycles. These sedimentary rocks have experienced multiple episodes of mafic volcanism. The sedimentary rocks from Vempalle and Tadpatri formations of the Palaeoproterozoic Papaghani sub-basin were analyzed for major, trace and rare earth elements (REEs) to discuss the sediment provenance, weathering process and to infer the depositional environment. The siliciclastic sedimentary rocks were collected from an outcrop section located near Parnapalle and Animela villages in the southwestern part of the Cuddapah Basin. The chemical index of alteration (CIA) values, 66% in Vempalle Formation and 58% in Tadpatri Formation, indicate source rocks have experienced low to moderate intensity of chemical weathering. The index of chemical variability (ICV) of these sedimentary formations varies from 1.6-1.8, suggesting chemical immaturity. The immobile elements geochemistry and normalized REE pattern suggest that the sediments are derived predominantly from felsic source rocks with subordinate contribution from mafic sources. The enrichment factor of redox-sensitive trace metals (V, Mo, and U) suggests that the depositional environment during the Palaeoproterozoic Vempalle and Tadpatri formations sedimentation is weakly oxic-suboxic.

PROJECT OUTCOME

Publications in SCI (Science Citation Index) Journals

1. Ansari AH, Singh VK, Kumar P, Sharma M, Sharma A, Patnaik S, Gundiga GP, Rahi IC, Ansari MA & Ramanathan AL 2023. Hydrogeochemistry, geothermometry, and sourcing of high dissolved Boron, Tungsten, and Chlorine concentrations in the Trans-Himalayan hotsprings of Ladakh, India. *Hydrology* 10(6): 118 (IF 3.2).
2. Ansari AH, Pandey SK, Ahmad S, Sharma M, Govil P, Chaddha AS & Sharma A 2023. High primary

productivity in an Ediacaran shallow marine basin influenced by strong seasonal to perennial upwelling. *Geological Magazine* 160(8): 1607-1623 (IF: 2.3).

3. Kumar C, Shukla Y, Sharma M, Harish Kumar SB, Malarkodi N & Khan SA 2023. Neoarchaeon stromatolites from the Dharwar Supergroup, India. *Current Science* 125(4): 435-441 (IF: 1.0).
4. Halla Jaana, Noffke Nora, Reis Humberto, Awramik Stanley, Bekker Andrey, Brasier Alexander, Callo Flávia, Choudhury Adrita, Duda Jan-Peter, Fedo Christopher, Galante Douglas, Haddock Jessica, Haines Peter, Hinnov Linda, Hofmann Axel, Homann Martin, Huston David, Johnson Simon, Kah Linda, Kaufman Alan, Kovalick Alex, Kuchenbecker Matheus, Köykkä Juha, Lowe Donald, Nhleko Noah, Reno Barry, Sanchez Evelyn, Shukla Yogmaya, Smith Albertus, Zuilen MV, Westall Frances, Whitehouse Martin 2024. Ratification of the base of the ICS Geological Time Scale: The Global Standard Stratigraphic Age (GSSA) for the Hadean lower boundary. Episodes <https://doi.org/10.18814/epiiugs/2024/024002> (IF 3.2).
5. Pandey SK, Ahmad S & Sharma M 2023. Discussion: *Dickinsonia tenuis* reported by Retallack et al. 2021 is not a fossil, instead an impression of an Extant 'fallen beehive' by S.K. Pandey, Shamim Ahmad & Mukund Sharma. *Jour. Geol. Soc. India*, v.99, 2023, pp.311–316. *Journal of the Geological Society of India* 99: 1033-1036 (IF: 1.3).
6. Pandey SK, Singh D, Sharma M, Ahmad, S & Bhan U 2024. A new palaeobiological assemblage from the Son Valley Bhandar Group and its implications on the age of the upper Vindhyan of India. *Palaeoworld* <https://doi.org/10.1016/j.palwor.2023.06.001> (IF: 1.7).

General Articles/Reports/Database Published

1. शांति सागर के तट पर प्राचीनतम जीवन की खोज. योगमाया शुक्ला. पुराविज्ञान स्मारिका, वर्ष 2023, अंक 2: 11-12.

SPONSORED PROJECTS (SP) & COLLABORATIVE PROJECTS (CP)

- SP 1.1. Correlation of Vindhyan in Son and Chambal valleys by using High-resolution Biostratigraphy, Chemostratigraphy, Palaeoredox reconstruction, Palaeoenvironment and Palaeogeography** (Sponsored by Oil and Natural Gas Corporation Ltd. (ONGC) w.e.f 06/09/2021).



Fig. SP 1.3 - Microstromatolites collected from Puga vents (left) and SEM image of a layer revealing fibrous network-like EPS.

Investigators: Veeru Kant Singh, SK Pandey, AH Ansari, Arvind K Singh, Bandana Shukla & Yogesh Kumar

The Vindhyan sediments encountered between 00-1786 m in drilled well Suket (SK-A) of the Chambal Valley and 85–3825 m in drilled well Kharkhari (KK-1) of the Son Valley are examined for organic-walled microfossils (OWMs) (acritarchs) to ascertain the ages. Overall comparison of OWMs association in the wells of the Chambal Valley sections inferred Ediacaran (early Ediacaran to late Ediacaran) age for the studied Vindhyan successions however early Mesoproterozoic to Neoproterozoic (Calymmian to Cryogenian) age was inferred for the Vindhyan sediments in the wells of Son Valley.

Process based physical sedimentology of both surface and subsurface lower Vindhyan sequences from Chambal Valley and Son Valley Vindhyan was carried out to decipher facies associations which were later utilized to correlate the lower Vindhyan sequences in both the sub-basins along with high resolution biostratigraphy and chemostratigraphy. This high-resolution Bio-, litho- and chemo-stratigraphy data was also utilized to interpret depositional environment of individual facies and overall basinal scale palaeogeographic reconstruction.

SP 1.2: Ediacaran Complex Acanthomorph Palynoflora (ECAP) based biostratigraphy of the Krol Belt of the Lesser Himalaya, Northern India: Significance for global correlation (Sponsored by SERB, New Delhi; No: EEQ/2021/000787 w.e.f. 09.03.2022).

Investigator: Veeru Kant Singh

The project aims to establish the Ediacaran Complex Acanthomorph Palynoflora (ECAP) based biostratigraphy of the Krol Belt exposed in Lesser Himalaya to understand the origin, antiquity, affinity, evolution, diversification, and potential refinement of biostratigraphic zonation during the Ediacaran Period. Petrographic thin sections of silicified black cherts of the Krol-A Formation of the Krol Syncline exposed in Solan Valley of the Himachal Pradesh and Krol D Formation of the Mussoorie Synclines exposed in parts of Uttarakhand have been studied. Microscopic observations of chert revealed excellent preservation of Early Ediacaran Complex Acanthomorph Palynoflora (ECAP) in Krol A cherts and microbial mat textures in Krol D cherts. Microbial mats comprise mat-forming cyanobacterial remains, i.e. *Eoentophysalis*; *Myxococcoides*, and *Siphonophycus* (Fig. 3). Further, taxonomic identification and their interpretations are in progress.

SP 1.3: Biomolecules preservation in modern and relict Ladakh hot spring deposits, with implications for finding life on Mars (Sponsored by SERB, New Delhi; No: CRG/2022/000460 w.e.f. 23.02.2023).

Investigator: A. H. Ansari

Microstromatolites collected from Chumathang and Puga were studied as they represent the early stages of microbial mat formation. SEM images have revealed multiple layers of mats in addition to the fibrous extra cellular matrix amongst the micro-stromatolite layers (Fig. SP 1.3). EDX data further supports the EPS with peaks of Carbon (C) and Oxygen (O) in addition to inputs of silica (Si) and a

variety of other metals (Ca, Mn, Au, and Ac). Gold (Au) and Actinium (Ac) in the EDX data probably hint at the fluids coming from a deep source at batholithic interaction with the fluid (?).

CP 1.1: GP Gurumurthy, KA Faizan, M Alam, A Sharma [& M Tripti, NIH, Roorkee]

The Himalayan River System (HRS) constitutes a major conduit for continental material transport to the adjacent oceans. The unresolved geological complexity and active tectonics of the Himalayas bring heterogeneity in sediment geochemistry. There is no known certified reference material (CRM) that represents the geochemical heterogeneity of HRS and large tropical rivers (LTR) though they rank first in terms of sediment transport and water discharge. As an ongoing exercise to develop reference material to calibrate the instruments and to validate the geochemical results, a river bedload sediment sample from the Ganga River Basin (GBS) which is representative of both HRS and LTR was collected in sufficient quantity and characterized for its geochemical composition using inductively coupled plasma instrumentation techniques (ICP-OES and ICP-MS). The GBS has been analyzed for major, trace, and rare earth elements (REEs) to infer the homogeneity and suitability of geological material for reference material characterization through the test of reproducibility and representativeness. The precision of measurement (% RSD) within and across the four analytical sessions is less than < 7 % for most of the elements measured. The method is validated with respect to precision, limit of detection (LOD), limit of quantification (LOQ), and measurement uncertainties by analyzing CRMs. The concentration values are reproducible and co-relatable with previously published datasets from the HRS. Thus, the GBS sample is developed as a potential matrix matching geological standard for geochemical studies of the Himalayan river sediments as well as other large tropical river systems.

CP 1.2: Arvind K. Singh [& SSK Pillai, BSIP]

Process based sedimentology of lower Gondwana Group, exposed in Sikkim-Darjeeling Himalayas exhibits older Rangit pebble-slate of early Permian age and is overlain by Damuda Formation of upper Permian age, was carried out for palaeoenvironmental analysis. Rangit pebble slate unit comprises diamictite bearing sandy and pebbly spotted slate, fine grained sandstone and slate. This unit has been correlated with basal Gondwana glacio-marine Talchir Formation of central India. This unit is overlain by Damuda Formation comprising coal bearing cyclic sequence of sandstone-shale horizons. A cyclic fining upward character with concave up lenticular channel deposit comprising conglomeratic unit at base and shaly top has been observed suggesting fluvial channel fill deposit for these sediments.

The carbonaceous shales within this unit have yielded Glossopterid floral assemblage.

CP 1.3: Arvind K. Singh [& Mohd. Arif, BSIP]

The Deccan volcano sedimentary succession comprising infratrappean beds of sandstone and shale units overlain by basaltic lava flows exposed at Banjari Mata Temple section near Paat Baba, Jabalpur, Madhya Pradesh was investigated for sedimentary attributes and depositional condition. Four distinctive facies namely, (a) fossiliferous purple shale, (b) pebbly cross stratified sandstone, (c) chevron cross stratified sandstone and (d) bipolar cross stratified fine sandstone have been identified. The detailed facies analysis reveals fining upward, lenticular, channelized argillaceous sandstone units deposited in stream/lacustrine environment with marine influence in its upper part.

OTHER ACADEMIC WORKS

Research Papers Presented

1. Shukla Y, Sharma M & Ansari AH - Microbial mats and microbialites of the Indian Archaean successions: characteristics and contrasts in global perspective in Palaeodown under 3 organised by The Geological Society of Australia, specialist group Australasian Palaeontologists (online). *In: Abstract book and Conference Guide: Palaeo Down Under 3, 10–14 July 2023. Australasian Palaeontologists, Perth, western Australia, p. no. 125, (10-14 July 2023).*
2. Ahmad S & Pandey SK - Unveiling the enigma: *Dickinsoniatenuis* of Retallack *et al.* - 2021- Not a fossil, but the imprint of a “fallen Beehive”. National Seminar on ‘Vindhyan Supergroup: Recent advances, challenges and opportunities (VISACOP)’, held at Geological Survey of India, Lucknow, 18 October, 2023.
3. Singh AK & Chakraborty PP - Process based facies analysis of argillaceous intervals of Palaeo-Mesoproterozoic Vindhyan basin: insights into sedimentation dynamics and basin tectonics. National Seminar on ‘Vindhyan Supergroup: Recent advances, challenges and opportunities (VISACOP)’, held at Geological Survey of India, Lucknow, 18 October, 2023.
4. Pandey SK, Sharma M & Ahmad S - The current chronostratigraphic status of Bhandar Group of the Vindhyan Supergroup. Vindhyan Supergroup: Recent advances, challenges, and Opportunities (VISACOP) held at Geological Survey of India, Northern Region, Lucknow on 18 October, 2023.



5. Pandey SK, Bykova N, Sharma M, Karlova GA, Ansari AH, Lan Z, Ahmad S & Pandit MK - Chronostratigraphic status of the Bilara carbonate of the Marwar Supergroup, western India. 39th Convention of Indian Association of Sedimentologists & International Conference on Voyage of sedimentology from the mountains to the Oceans: An innovative trajectory held at Department of Earth Science, Annamalai University, India on 6–8 December, 2023.
6. Singh D - Petrological and geochemical studies of the peculiar carbonate concretions of the Rohtasgarh Limestone, Sonbhadra District, and their significance. Vindhyan Supergroup: Recent advances, challenges, and Opportunities (VISACOP) held at Geological Survey of India, Northern Region, Lucknow on 18 October, 2023.
7. Singh VK & Sharma M - Exceptionally preserved macroscopic carbonaceous compression fossils from the Early Mesoproterozoic Singhora Group, Chhattisgarh Supergroup, India and their interpretation as benthic seaweeds. 39th Convention of Indian Association of Sedimentologists & International Conference on Voyage of sedimentology from the mountains to the Oceans: An innovative trajectory held at Department of Earth Science, Annamalai University, India on 6–8 December, 2023.
8. Jain A & Singh VK - New record of Ediacaran Complex Acanthomorphic Palynoflora (ECAP) from the Mahi Formation of the Krol Belt, Lesser Himalaya, India. 39th Convention of Indian Association of Sedimentologists & International Conference on Voyage of sedimentology from the mountains to the Oceans: An innovative trajectory held at Department of Earth Science, Annamalai University, India on 6–8 December, 2023.
9. Khan FA, Gurumurthy GP, Singh AK, Ahmad K & Alam M - Provenance characterization and geochemical studies of argillaceous sedimentary rocks of Palaeoproterozoic formations of Cuddapah Basin, India. 39th Convention of Indian Association of Sedimentologists & International Conference on Voyage of sedimentology from the mountains to the Oceans: An innovative trajectory held at Department of Earth Science, Annamalai University, India on 6–8 December, 2023.
10. Ahmad K, Singh AK, Gurumurthy GP, Khan FA & Arif M - Signatures of ramp-rimmed carbonate platform setting from Palaeoproterozoic Vempalle Formation, Papaghani Group, Cuddapah Basin: A sedimentological perspective. 39th Convention of Indian Association of Sedimentologists & International Conference on Voyage of sedimentology

from the mountains to the Oceans: An innovative trajectory, held at Department of Earth Science, Annamalai University, India on 6–8 December, 2023.

Deputation to Conferences/Seminars/Workshops (both online and offline)

Yogmaya Shukla, Mukund Sharma & Arif H Ansari

- International Conference “Palaeodown under 3” organized by The Geological Society of Australia, specialist group Australasian Palaeontologists from July 10-14, 2023 (online).

Veeru Kant Singh, SK Pandey, Arvind K Singh, Abhinav Jain, Kumail Ahmad & Faizan Ahmad Khan

- 39th Convention of Indian Association of Sedimentologists & International Conference on Voyage of Sedimentology from the mountains to the Oceans: An innovative trajectory, Department of Earth Science, Annamalai University, India on 6–8 December, 2023 (offline).

Abhinav Jain & Kumail Ahmad

- Training-cum-Field Workshop on Decoding clastic sedimentary systems organized by the Department of Geology, Aligarh Muslim University, Aligarh, from 21-25 February, 2024 (offline).

Training/Study Visits

Arif Husain Ansari

- Arif Husain Ansari & Arunaditya Das conducted a field visit for the study of modern and relict Ladakh hot-spring deposits in Ladakh (Nubra and Indus valleys), U.T., India, Duration – 29th July, 2023 - 8th August, 2023.

Gurumurthy G.P.

- Imparted training to Mr. Akash Patil (Dissertation-2023), Department of Chemistry, Lucknow University, Lucknow.
- Imparted training to Ms. Aditi Bajpai (Intern- 2023), Department of Geology, Lucknow University, Lucknow.

Veeru Kant Singh, S. K. Pandey, Arvind K Singh, Bandana Shukla & Yogesh Kumar

- Visited KDMIPE ONGC, Dehradun under BSIP-ONGC Collaborative Project on Vindhyan Basin during August & November, 2023 and January, 2024.

Veeru Kant Singh

PH.D. PROGRAMMES

	Yogesh Kumar (2017). Palaeobiology and chemostratigraphy of the Kurnool Group, South India, under the supervision of Mukund Sharma (BSIP) , Prof. Shreerup Goswami, Sambalpur University, Odisha. Status: Awarded (July 2023).
	Mahboob Alam (2018). Palaeoclimatic and palaeoceanographic studies of Eastern Arabian Sea using geochemical and isotopic proxies, under the supervision of Gurumurthy GP (BSIP) , Komal Verma (BHU), Banaras Hindu University, Varanasi. Status: Awarded (February 2024).
	Mohammad Arif Ansari (2021). Study of the Holocene OMZ dynamics in the Eastern Arabian Sea (EAS), under the supervision of Arif Husain Ansari (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Divya Singh (2019). Palaeobiology and geochemistry of chemically precipitated rocks of the Semri Group, Vindhyan Supergroup in understanding the evolution of life, under the supervision of Mukund Sharma (BSIP) , S.K. Pandey (BSIP) & Bindhyachal Pandey (BHU), Banaras Hindu University, Varanasi. Status: In-progress.
	Faizan Ahmed Khan (2022). Geochemical evolution of Earth's hydrospheric environment during the Neoarchaeon and Paleoproterozoic Era: Evidences from Dharwar Craton, under the Supervision of Gurumurthy GP and Arvind K Singh (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR). Status: In-progress.
	Kumail Ahmad (2022). Sedimentological and geochemical evolution of argillaceous and carbonate successions from Cuddapah Basin, under the supervision of Arvind K Singh and Gurumurthy GP (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Archana Sonker (2023). Microbial community structure and their metabolic activities in the hotspots of Ladakh, under the supervision of Arif Husain Ansari (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR). Status: In-progress.
	Arunaditya Das (2023). Organic biomarker preservation potential in high-altitude hot spring deposits of Ladakh: an astrobiological implication, under the supervision of Arif Husain Ansari (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR). Status: In-progress.

- Imparted training to Ms. Einas Noman, M.Sc., Applied Geology, ONGC -Centre of Advanced Studies, University of Lucknow on topic 'Morphology and significance of Acritarchs in Proterozoic stratigraphy during July-August, 2023.
- Imparted training to Mr. Ahmad Jamal, M.Sc., Applied Geology, ONGC -Centre of Advanced Studies, University of Lucknow on topic 'Organic walled microfossils- their extraction technique, morphology and significance' during July-August, 2023.
- Imparted training to Ms. Priya Singh, M.Sc., Applied Geology, ONGC -Centre of Advanced Studies, University of Lucknow on topic 'Morphology and significance of Acritarchs in Proterozoic stratigraphy during July-August, 2023.
- Imparted training to 5 ONGC officials (Herry Gilbert, Rakesh Sahu, Devyani Singh, Sumit Chauha &

Sankalp Saklani) on Precambrian Acritarchs and their morphology and biostratigraphic significance, during February, 2024.

Lectures delivered

Arif Husain Ansari

- Developing tools and strategy through analog studies for analyzing organic compounds in Martian samples at the National Seminar on Grand Challenges in Earth System Sciences, organized by the Institute of Environment and Sustainable Development, Banaras Hindu University during 1-3 April, 2023 (Keynote lecture).

Arvind Kumar Singh

- Understanding the earth's surface: an insight on



sediment-biota interaction & biosphere response to earth's past climate on 02nd November, 2023 in UGC-HRDC Refresher Course in Geography and Environmental studies on the topic (Invited lecture).

CONSULTANCY/ TECHNICAL SUPPORT RENDERED

Veeru Kant Singh

Confocal Laser Scanning Microscopy (CLSM) – RAMAN Spectroscopy Lab

- National Institute for Pharmaceutical Education and Research, Raebareli –INR 9,440.
- BSIP, Lucknow – INR 5,900.

Gurumurthy, G.P.

- Major and trace element analysis using ICP-MS and ICP-OES - INR 50,000.

ACCOLADES RECEIVED

Arif Husain Ansari

- Key-note Speaker, National Seminar on Grand Challenges in Earth System Sciences, organized by the Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi, during 1-3 April, 2023.

Arvind Kumar Singh

- Invited as Distinguished Speaker in an International Conference on “Voyage of Sedimentology from the mountains to the oceans: An Innovative Trajectory and 39th convention of Indian Association of Sedimentologists” organized by Department of Earth Sciences, Annamalai University, Chidambaram, Tamil

Nadu, India on 06th –08th December, 2023.

- Invited as Resource person for Training-cum-Field Workshop on “Decoding Clastic Sedimentary Systems” organized by Department of Geology, Aligarh Muslim University under the aegis of Indian Association of Sedimentologists, 20th -25th February, 2024.

Veeru Kant Singh

- Received the prestigious Sharda Chandra Gold Medal 2022 from the Palaeontological Society of India, University of Lucknow, Lucknow, October, 2023.

REPRESENTATION IN COMMITTEES/BOARDS

Arif Husain Ansari

- Consortium Member of Sedimentary Geochemistry and Palaeoenvironments Project, Stanford University, USA (for more details, check <https://sgp.stanford.edu/who-we-are>)

Yogmaya Shukla

- Voting Member of the Sub-commission on Pre-Cryogenian Stratigraphy –International Commission of Stratigraphy (ICS-Pre-Cryogenian)

Gurumurthy G.P.

- Associate Editor, Arabian Journal of Geosciences, Springer.
- Doctoral Advisory Committee Member of Manipal Academy of Higher Education, Manipal.

Shamim Ahmad

- Academic Editor for PLOS ONE journal.

Project 2: Biostratigraphy, Basin Correlation, Climatic and Biotic events during Palaeozoic and Mesozoic

COORDINATOR: SRIKANTA MURTHY (SCIENTIST E)

CO-COORDINATOR: ANJU SAXENA (SCIENTIST E)

OBJECTIVES

- To resolve the age constraints of the Talchir Formation based on palynological correlations with radiometrically constrained assemblages across Gondwana and associated palaeoclimate changes across the glacial and postglacial sequences.
- To comprehend pathways and timings of marine incursions and sequence biostratigraphic framework across Gondwana deposits during the late Palaeozoic-Mesozoic sequences.
- To assess and delineate the events of biotic crisis-recovery and subsequent radiation of biota and extreme climatic events (OAEs) across the Permian-Triassic and Jurassic-Early Cretaceous sequences.
- Evolution of plant ecosystem with special emphasis on radiation of seed plants and phylogenetic studies to trace the early Angiosperms evolution in Indian context.

PREAMBLE

The research work of Gondwana Palaeobiology Group covers a large time slice of deep time sediments encompassing Cambrian to Early Cretaceous time period (~100 to 545 Ma old). One aspect of the research work mainly focuses on understanding the explosion of life

during the Cambrian and evolution and subsequent radiation of terrestrial plants, evidences for which are stored in the early Palaeozoic rocks of Tethyan realm particularly in Himachal Pradesh. Another major focus is on the study of 'Gondwana' successions (300-100 Ma) of peninsular India which are the major store house of coal deposits of country and are exclusively distributed in Damodar, Rajmahal, Son-Mahanadi, Satpura and Wardha-Godavari basins along with some parts of extra peninsular region. Gondwana Basins of India account for nearly 99% of coal resource of the country and hold a premier position in India for having a considerable share of reserve of thermal grades non-coking coal for catering to the demand of coal in various parts of the country. Contemporaneous sequences are known from most of the Southern Hemisphere continents suggesting former amalgamation of these landmasses. The research activities mainly aim to resolve issues related to biostratigraphy, palaeoclimate and hydrocarbon exploration with integration of microfossils and macrofossil assemblages, along with sedimentological and geochemical parameters. Emphasis is also being made to understand the evolution of flowering plants. The research findings contribute towards the understanding of the geochronological framework of Gondwana regions, origin and evolution of land plants during the Palaeozoic and Mesozoic times and the potential influence of latitudinal controls on the flora and fauna through time. It also provides insights into the vegetation, palaeoclimate and associated tectonics that contributed to the formation of coal.



1st Row (L to R): Deepa Agnihotri, K. Pauline Sabina, Srikanta Murthy, Anju Saxena, S. Suresh K. Pillai, Neha Aggarwal; **2nd Row (L to R):** Sabyasachi Mandal, Shivallee Srivastava, Divya K. Mishra, Abha Singh, Neelam, Sabera Khatoon, Ayushi Mishra, Suyash Gupta, Alok Mishra; **3rd Row (L to R):** Ranveer S Negi, Suraj K. Sahu

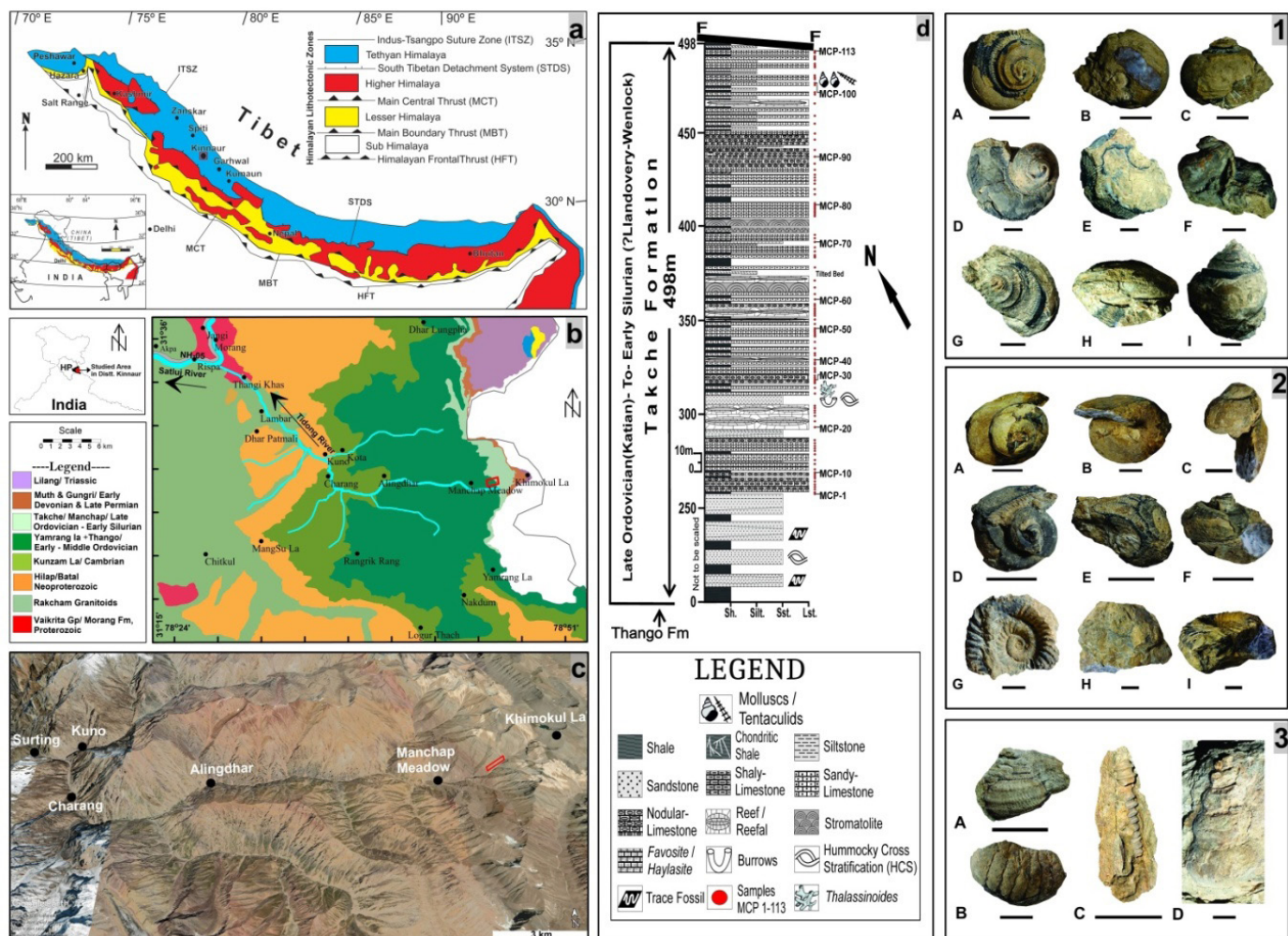


Fig. 1 - Gastropods, cephalopods and tentaculid fauna of Takche Formation (Ordovician-Silurian) from the Tidong Valley (Kinnaur) of Tethyan Himalaya. Specimens are photographed in the lab, except at Plate 3d, which is in situ. In Plates 1 and 2: A is front, B is back and C is the side view of same specimen, similarly are DEF and GHI. All scale bars are 1 cm.

PERSONNEL INVOLVED

Team Members: K. Pauline Sabina (Scientist E), S. Suresh K. Pillai (Scientist E), Deepa Agnihotri (Scientist E), Abha Singh (Scientist D), Neha Aggarwal (Scientist D), Neelam Das (Scientist D), Divya Kumari Mishra (Scientist B), Ranveer S. Negi (Scientist B), Sabyasachi Mandal (Scientist B)

Associate Member: Runcie Paul Mathews (Scientist D), Gurumurthy GP (Scientist C)

Technical Support Members: Shivalee Srivastava (Technical Assistant B)

Research Scholars: Raj Kumar, Suyash Gupta, Alok Mishra, Deveshwar P. Mishra, Nazim Deori, Suraj Kumar, Ayushi Mishra, Sabera Khatoon.

SIGNIFICANT FINDINGS

A low diverse collection of Late Ordovician gastropods *Poleumita* sp. (Fig. 1, Pl. 1A-I; Pl. 2D-F), *Holopea*? sp. (Fig.

1, Pl. 2A-C), *Cyclonema* sp. (Fig. 1, Pl. 3A), *Hormotoma* sp. (Fig. 1, Pl. 3D); cephalopod *Discoceras* sp. (Fig. 1, Pl. 2G-I), unidentified nautiloids (Fig. 1, Pl. 3B); and rare *Tentaculites* sp. (Fig. 1, Pl. 3C), among others, were recovered from the carbonate-bearing succession (261 to 498 m) of Takche Formation (Ordovician-Silurian) (Fig. 1d) from the Tidong Valley (Kinnaur) of Tethyan Himalaya (Fig. 1a, b, c). This is the first report of large-body fossils from the Ordovician-Silurian successions of the Kinnaur region. The reported Late Ordovician gastropods are also known from Baltica, suggesting a probable oceanic link between these remote regions. The genus *Discoceras* occurred in the Gondwanan-related terrains in the Late Ordovician and thus indicates palaeobiogeographic links to Gondwana. *Tentaculites* from the formation does not resemble any Baltic or North American tentaculitoids and shows greater resemblance to the tentaculitoids from the other Gondwana regions. In eastern North America, the abundant *Subulites* and co-occurring taxa *Hormotoma*, *Holopea*, *Lophospira*, *Maclurina* and *Omospira* consistently indicate inner shallow subtidal settings (BA2). *Hormotoma* sp. and *Holopea* sp. in the Takche Formation

Age	General characteristics of the palynoassemblages	West Gondwana			East Gondwana		
		South America	Arabia	Africa	India	Antarctica	Australia
Late Permian	Dominance of striate bisaccates- <i>Protohaploxypinus</i> spp., <i>Striatopodocarpites</i> spp	Eolian Deposits	Evaporites		Coal deposits		
					Red beds		
Early Permian	Dominance of non-striate bisaccates- <i>Scheuringipollenites</i> spp.	Coal/Oil			Coal deposits		
					Deglaciation		
Late Carboniferous	Dominance of monosaccates- <i>Cannanoropollis</i> spp., <i>Plicatipollenites</i> spp., <i>Potonieisporites</i> spp., and spores- <i>Punctatisporites</i> spp., <i>Cristatisporites</i> spp.,				Glacial deposits		

Fig. 2 - General palynological and lithological characteristics of the late Paleozoic sequences across Gondwana.

may also suggest an inner shallow subtidal environment.

Correlation of the Indian Gondwana late Palaeozoic palynoassemblages with their coeval counterparts across Gondwana revealed that the late Carboniferous and early Permian palynoassemblages from the Talchir and Barakar formations of India showed gross similarities with their coeval counterparts across Gondwana with minor

differences which is due to phytogeographic provincialism (Figs 2, 3). But correlations with the late Permian palynoassemblages were not feasible and the reasons for the same were studied and the following inferences have been drawn. The similarities in the late Carboniferous and early Permian palynoassemblages across Gondwana is due to the fact that during this interval, Gondwana occupied high southern palaeolatitudes invariably resulting in late

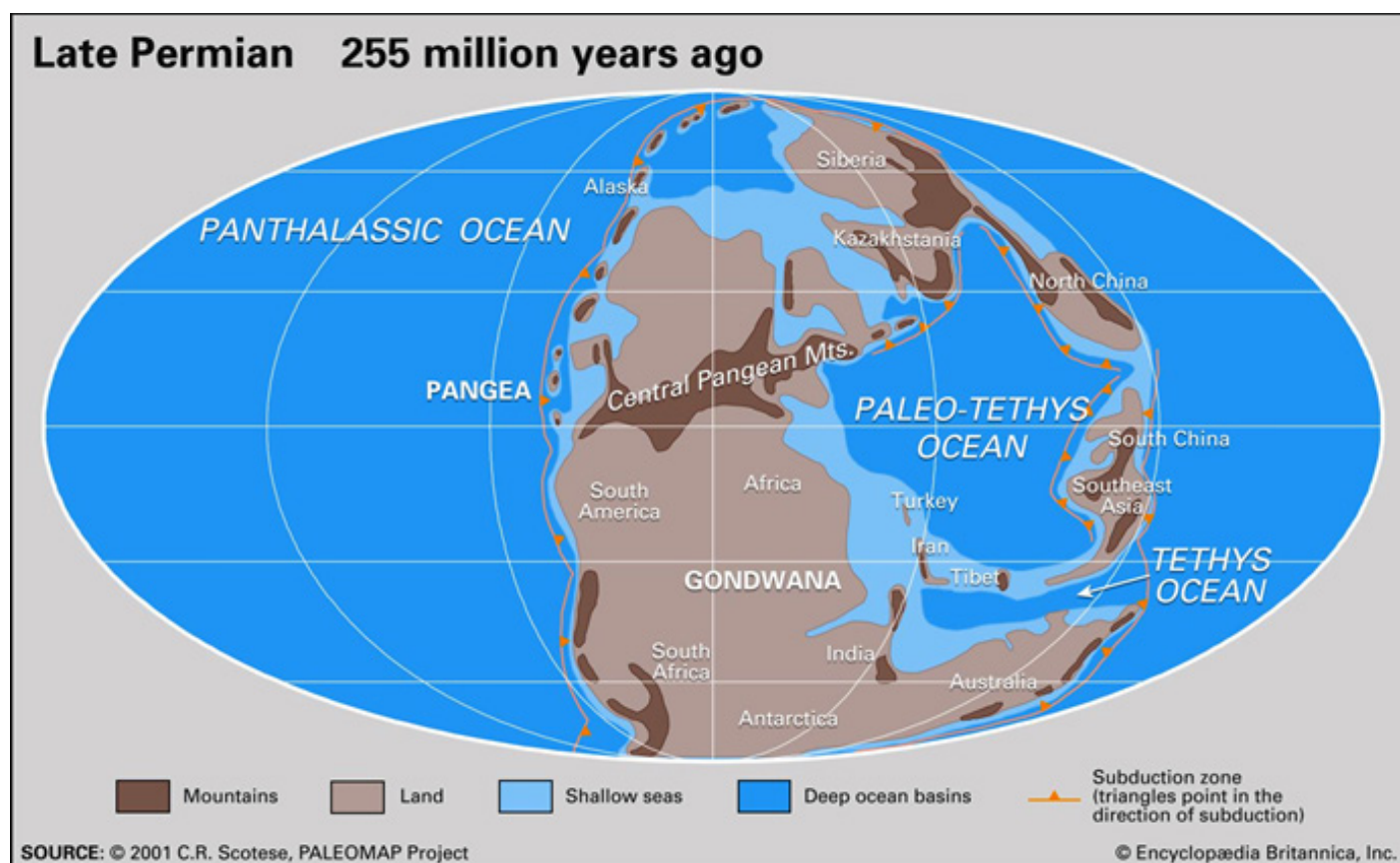


Fig. 3 - Palaeogeographic position of east and west Gondwana during the late Permian (after Scotese, 2001). Note: East Gondwana reveals proximity to palaeotethys resulting in coastal plain to fluvio deltaic environment favouring extensive coal measures, whereas west Gondwana shows continentalization due to long volcanic chain obstructing humid winds from the west (Protopacific ocean) and east (Protoatlantic ocean) favouring the formation of eolian deposits.

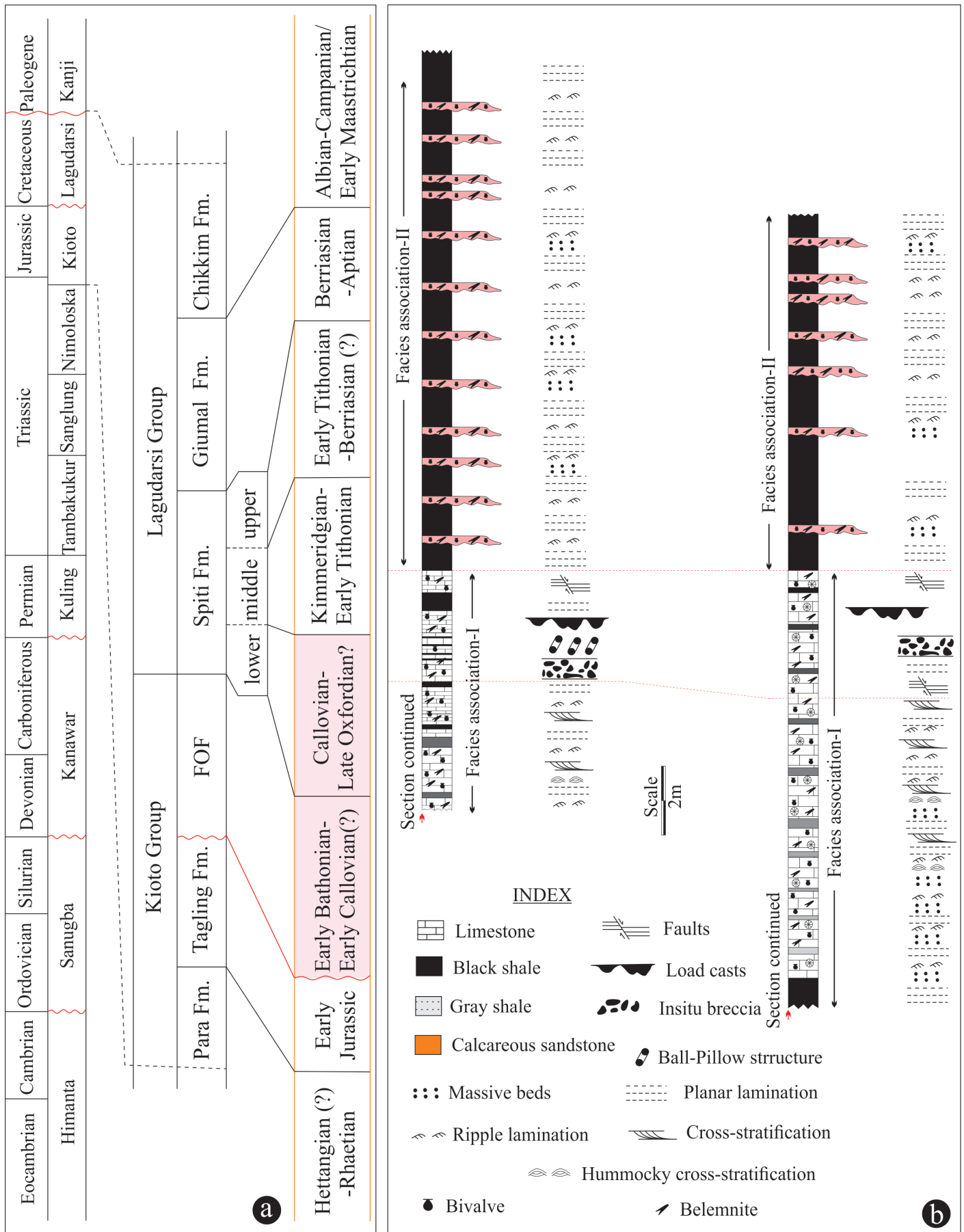


Fig. 4 - Lithostratigraphy and biostratigraphy distribution in parts of Spiti Himalaya sequence (a, note the age of studied succession marked by pink color), lithological log in two best locations from FOF to lower member of SF (b, note the SSDS zone at top part of FOF, distance from one section to another section ~1 km).

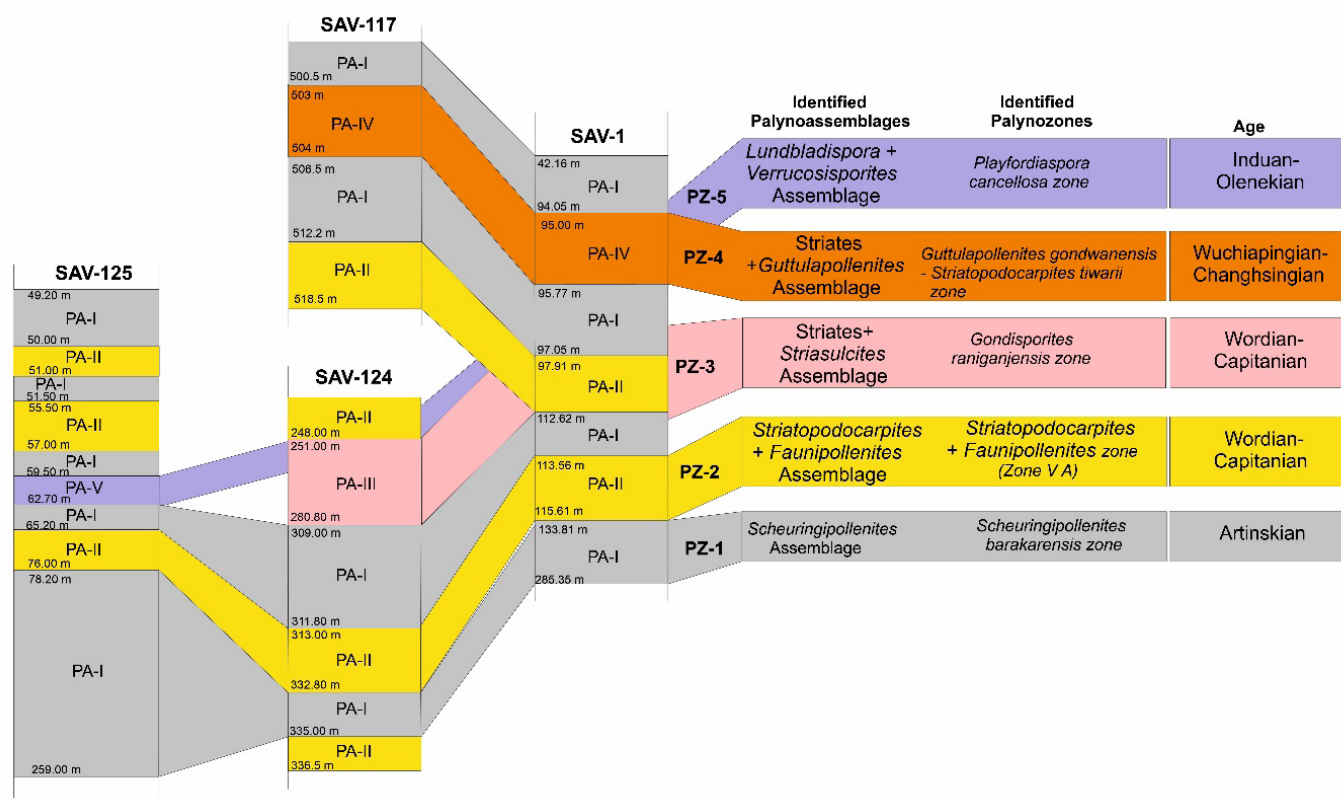


Fig. 5 - Correlation of the studied boreholes from the Vaddugudem block.

Carboniferous to early Permian glacial and periglacial deposits. Deglaciation occurred in early Sakmarian time, evidenced by a typical, commonly transgressive facies. After deglaciation the basic depositional theme was modified, depending on postglacial adjustments of climate and on the type of regional tectonic regimes (Wophner and Jin, 2009). Thus the pre deglaciated sequences could be correlated across Gondwana. Whereas, the post deglaciated sequences differed based on postglacial adjustments of climate and on the type of regional tectonic regimes.

During the late Permian in east Gondwana comprising India, Antarctica and Australia the southern humid belt covered almost the whole area of east Gondwana located south of 55-60°S and was characterized by coal-bearing basins with alluvial, alluvial-lacustrine, alluvial-floodplain and boggy sediments (Zharkov & Chamkov, 2001).

- India had close proximity to the Palaeotethys Ocean resulting in coastal plain to fluvio deltaic environment which had favoured the formation of extensive coal and associated sediments. During the Guadalupian-Lopingian southern South America occupied palaeolatitudes approximately 30-45°S falling in the semiarid-arid belt.
- Stratigraphic records of the southern South American basins show progressive continentalization from the Guadalupian to the Permo-Triassic boundary

resulting in semiarid to arid conditions.

- This has been likely related to the long volcanic barrier, the Choiyoi igneous province in western margin of South America (Argentina and Chile separating these basins from the Permian sea and transforming almost the entire area into an inland.
- As a Consequence, humid winds from the west (Protopacificocean) and east (Protoatlantic ocean) were obstructed favouring the formation of eolian deposits.

Thus, late Carboniferous to early Permian sequences are more correlatable than the late Permian sequences across Gondwana.

The present study highlights the importance of sedimentological analysis to distinguish the seismite and its implications on palaeogeographic evolution and sedimentary architecture (Fig. 4). In the Middle Jurassic succession of Spiti Himalaya, the topmost part of the Ferruginous Oolitic Formation (FOF) consists of three layers of Soft Sediment Deformation Structure (SSDS) and it is underlain by the Callovian sediments of lower member of the Spiti Formation (SF). The sedimentary facies analysis documents the palaeogeographic shift from the middle shelf (carbonate-shale repository: FOF) to the outer shelf (black shale: lower member of SF). The SSDS layers, exhibiting load casts, ball and pillow structures,

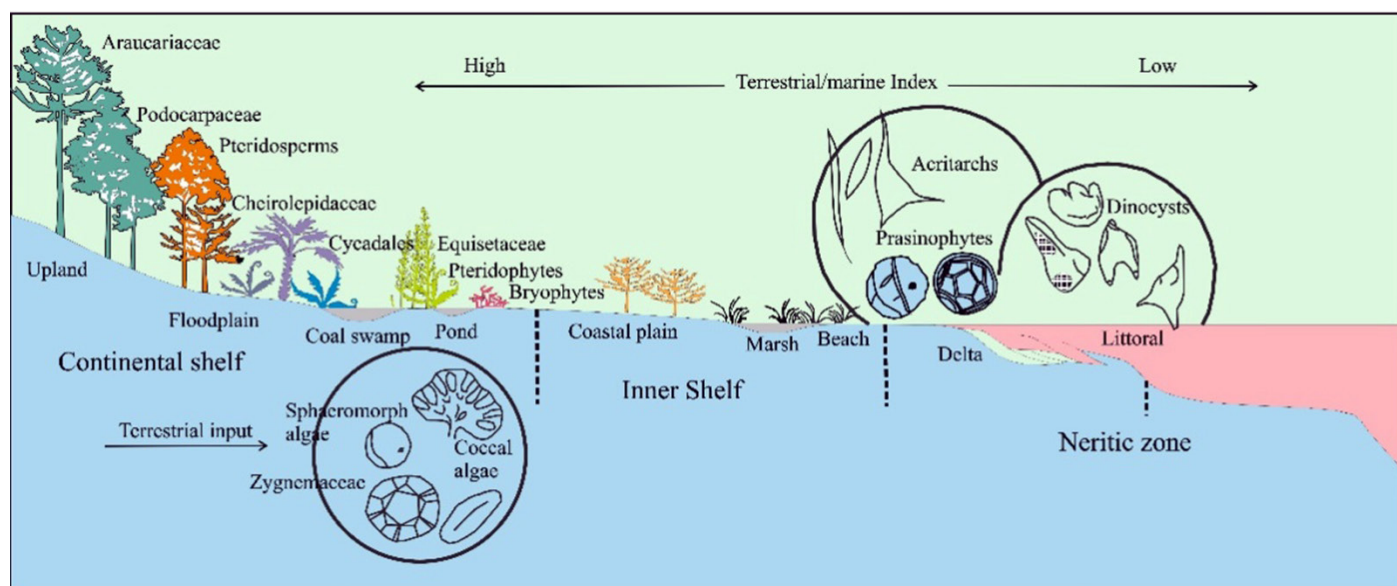


Fig. 6 - Palaeodepositional model of the Gangapur Formation, Jangareddygudem area, Godavari Valley Coalfield, south India (after Prauss, 2000).

indicate gravitational instability, while syn-sedimentary faults and in situ breccia are the results of brittle deformation. The dominance of storms in depositional sites often argues for a possible triggering agent for SSDS. The lateral continuity, vertical repetition, confinement of SSDS at the top part of FOF and sharp change of facies assemblage indicate seismicity-induced syn-sediment deformation, i.e. seismite. The transition from middle shelf to outer shelf at the onset of seismite indicates that seismic impact possibly caused the rapid subsidence, resulting in the palaeogeographic shift. The rapid transgression is recorded as carbonate-shale repository to anoxic black shale.

The Vaddugudem block of the Godavari Valley Coalfield was palynologically investigated. Five distinct palynozones (PZ-1—PZ-5) were identified, dating from Artinskian to Induan—Olenekian (Figs. 5, 6). Identified palynozones are found to be interrupted / discontinuous. The study highlights the application of palynology in identifying disturbed chronostratigraphic units.

Palynological analysis in Jangareddygudem, south India, identified the age (upper Aptian to lower Albian) and depositional settings in the Godavari Graben. The study in the Chintalapudi sub-basin of the Godavari Valley Coalfield highlights a marine incursion. The study uses palynofacies and *Botryococcus* morphotypes as benchmarks (Fig. 6).

Fluvial sedimentary deposits in the Godavari Valley Coalfield, South India first time investigated to identify the major system tracts and their potential for hydrocarbon generation (Fig. 7).

The Early Permian floral diversity, palaeoenvironment,

palaeoclimate and depositional setting were studied using multiproxy approach that included morphotaxonomy, palynology and organic geochemistry of Karo OCM (Open Cast Mine), East Bokaro Coalfield, Damodar Gondwana Basin, India (Fig. 8). The macroplant fossil assemblage exhibits the presence of *Glossopteris*, comprising *Glossopteris*, *Gangamopteris* and *Vertebraria*, as well as Coniferales, which includes *Noeggerathiopsis*. The palynological assemblage encompasses the dominance of the striate bisaccate pollen *Faunipollenites* sp. and the sub-dominance of the non-striate bisaccate pollen *Scheuringipollenites* sp. with *Glossopteris* affinities. The megafloral and palynofloral assemblage confirms the biostratigraphical age to be Upper Barakar palynoflora of Kungurian affinity. The studied morphological characteristics led us to envisage the presence of dense forest and warm and humid climate during Upper Barakar Formation. The organic geochemical characterization based on functional group and biomarker analyses reveals the diagenetic effects on organic matter. Aliphatic symmetric ($\sim 2865\text{--}2855\text{ cm}^{-1}$) and asymmetric stretching ($\sim 2930\text{--}2910\text{ cm}^{-1}$) peaks are identifiable in coal samples, whereas they are absent in carbonaceous shale. The A-factor vs. C-factor plot suggests that the kerogen type is Type III, which can generate mainly gaseous kerogen. The vitrinite reflectance studies (R_r av. 1.1%) show increased maturity of the samples, which is supported by the *n*-alkane distribution pattern and the absence of hopaneterpenoids. The Indian floral assemblages in contemporary of southern Gondwana continents reveal a stronger inclination/affinity with the flora of Africa than that of South America, thereby supporting the age to be of Artinskian-Kungurian (Fig. 8).

Palynological and macro-charcoal studies have been carried out on fossiliferous material from the upper seam of the

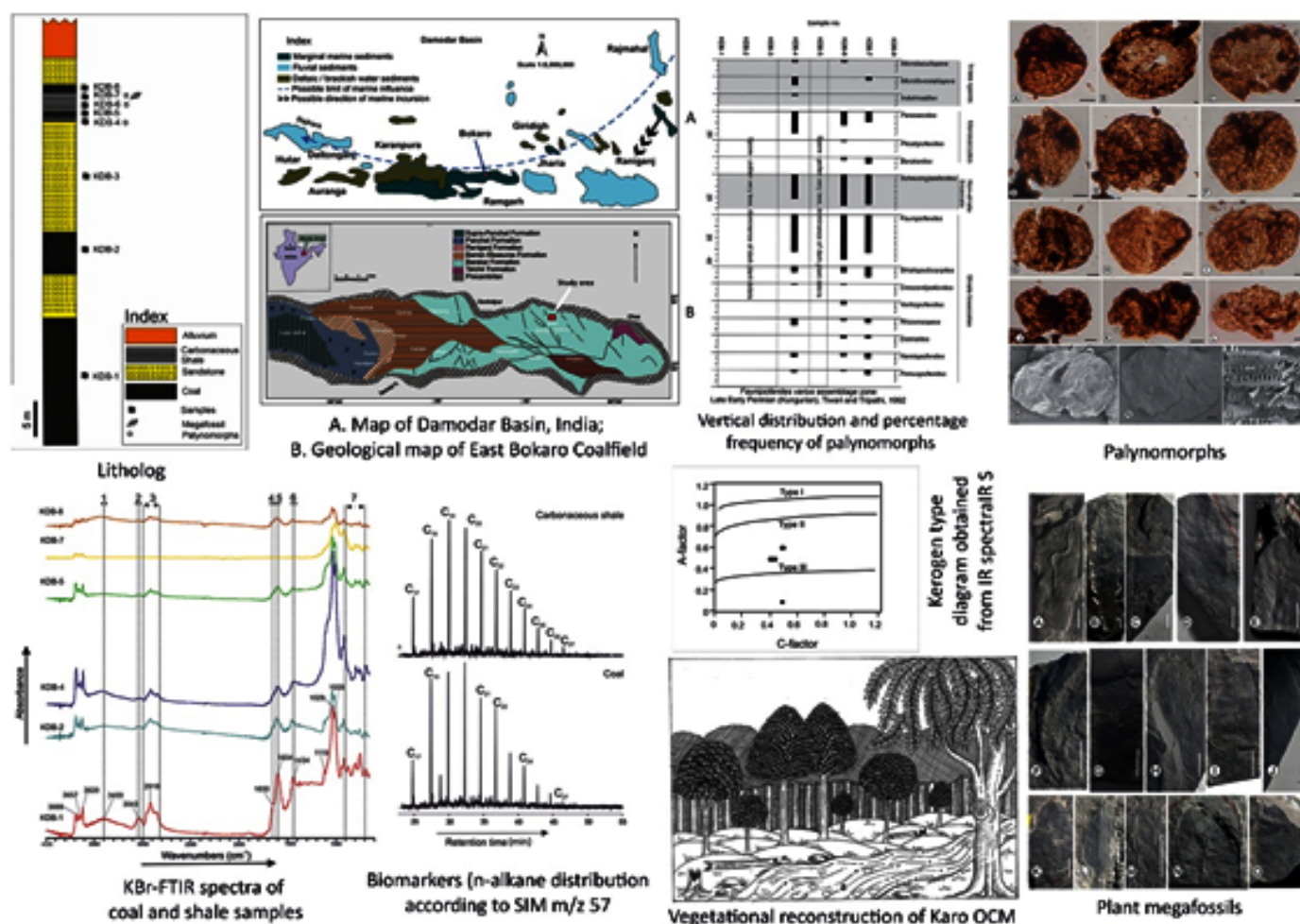


Fig. 8 - Palaeofloristic studies based on multiproxy analyses to infer palaeoenvironment and palaeofloral diversity during Permian.

wildfire events during deposition of the Valanginian-Hauterivian as well as Barremian? strata of the Rajmahal Formation in the Raniganj Coalfield, West Bengal, India. These occurrences represent so far the oldest Cretaceous records for palaeo-wildfires on the Indian part of the former super-continent Gondwana, adding further proof that wildfires were globally distributed during this period.

Megafossil and palynological assemblages recovered from the grey shale and shale facies associated with sandstones and coal-bearing horizons in Kakri Colliery have been analysed to deduce the floral diversity, age assessment and palaeoenvironment of the studied region. A rich and less diverse assemblage has been found preserved in these facies. The occurrence of megafossils in Kakri Colliery is relatively less as compared to coeval sequences of Son Basin. Further, almost all the fossils are impressions with rare fragmentary patches of compression, i.e. the megafossils are hardly found preserved with cuticle, depicting the complete oxidation of the carbon content of the preserved fossils at least in these facies. The Kakrimacroflora is dominated by the order Glossopteridales followed by Cordaitales and is represented by *Gangamopteris*, *Glossopteris* and *Noeggerathiopsis*. The presence of monosaccate and bisaccate pollen and spores from the

Barakar Formation having representatives of Cordaitales, Glossopteridales, Coniferales and Equisetales indicates that the dense vegetation has been growing in the surrounding area. Identification of *Scheuringipollenites barakarensis* and *Faunipollenites varius* Palynoassemblage Zones in the Purewa Bottom seam of Kakri Colliery has led to the assignment of late Early Permian (Kungurian–Upper Barakar) age to Purewa Bottom coal seam.

The Mesozoic plant megafossil assemblage of Motayaksh is chiefly constituted of *Ptilophyllum*, *Bucklandia*, *Ctenozamites*, *Taeniopteris*, *Brachyphyllum*, *Elatocladus*, *Pachypteris* and *Coniferocaulon*. Bennettitales and Conifers are dominant. Pteridosperms are also in fair number. Pteridophytes are very rare. The overall assemblage is more like the ones commonly met within the Middle Jurassic of Graham Land and Yorkshire. The dominance of *Ptilophyllum* is also known from the various localities (Bindaban, Onthea, Amarjola) belonging to Rajmahal Formation, but conifers are rather rare in these localities. In the Rajmahal Hills, the Conifers are more common only at Nipania, but bennettitales are extremely rare. In Bennettito-Coniferous dominance, it also resembles Krishna Godavari and Cauvery basins.

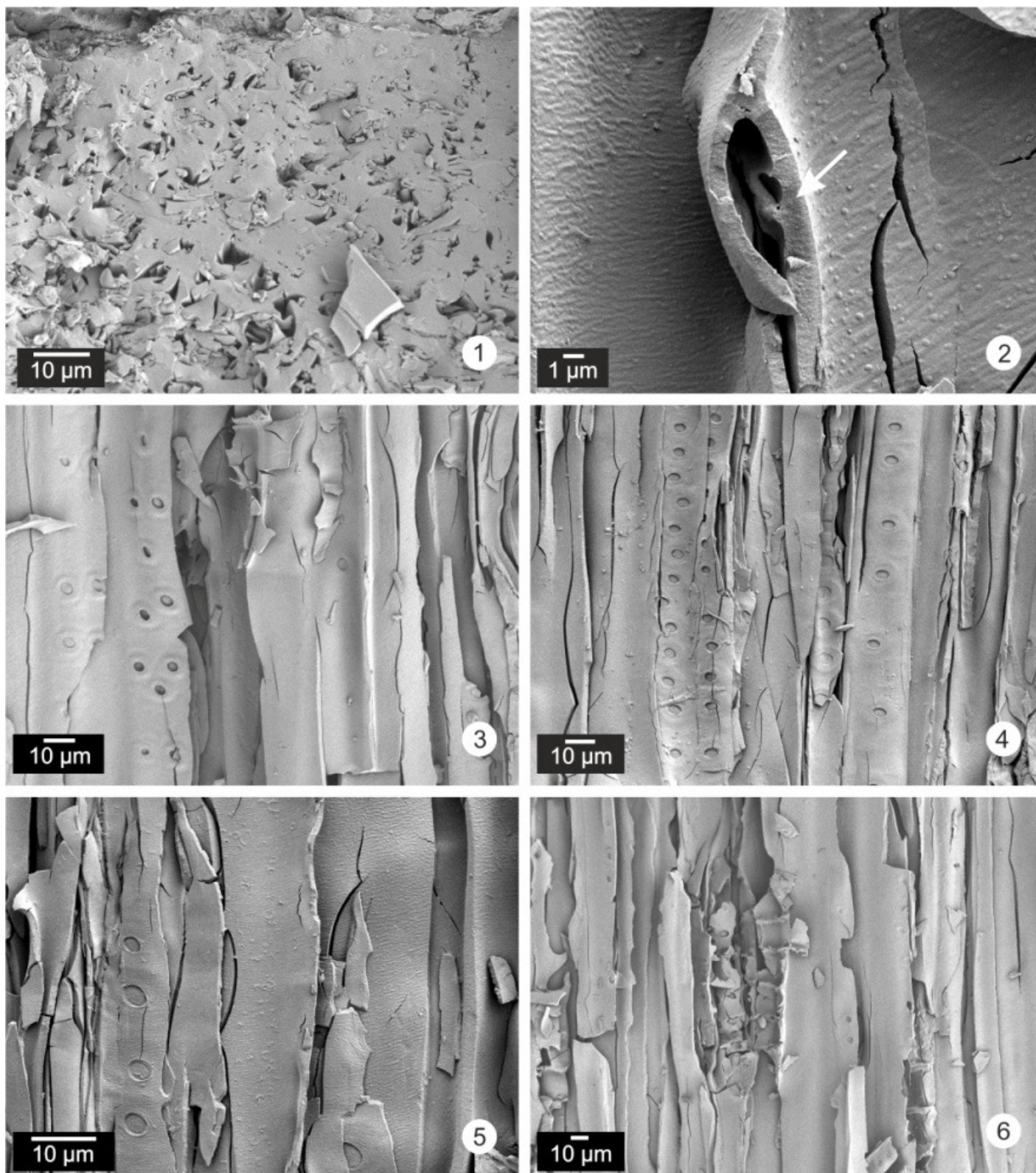


Fig. 9 - SEM images of charcoal from the early Permian of the Chuperbhita Coalfield, Rajmahal Basin, Jharkhand (India).

The flora of the Rajmahal Formation typically known as 'The Early Cretaceous (Barremian to Aptian) Rajmahal Flora' is one of the most interesting Mesozoic floral successions characterized by prolific and diversified floral entities. A number of floral elements of Rajmahal Flora have been under continuous taxonomic reassessment, particularly enigmatic macro-remains of angiosperms. The presence of definite pollen records with angiospermous

affinity from the Rajmahal Formation suggests the potential existence of its megafossils. Consequently, various claims have been put forward by different authors regarding the presence of angiosperm megafossils within the formation. The present study provides an updated synthesis and analysis of the palaeofloritics of the Rajmahal Formation and underlying Dubrajpur Formation and its relevance in tracing the angiosperm evolution.

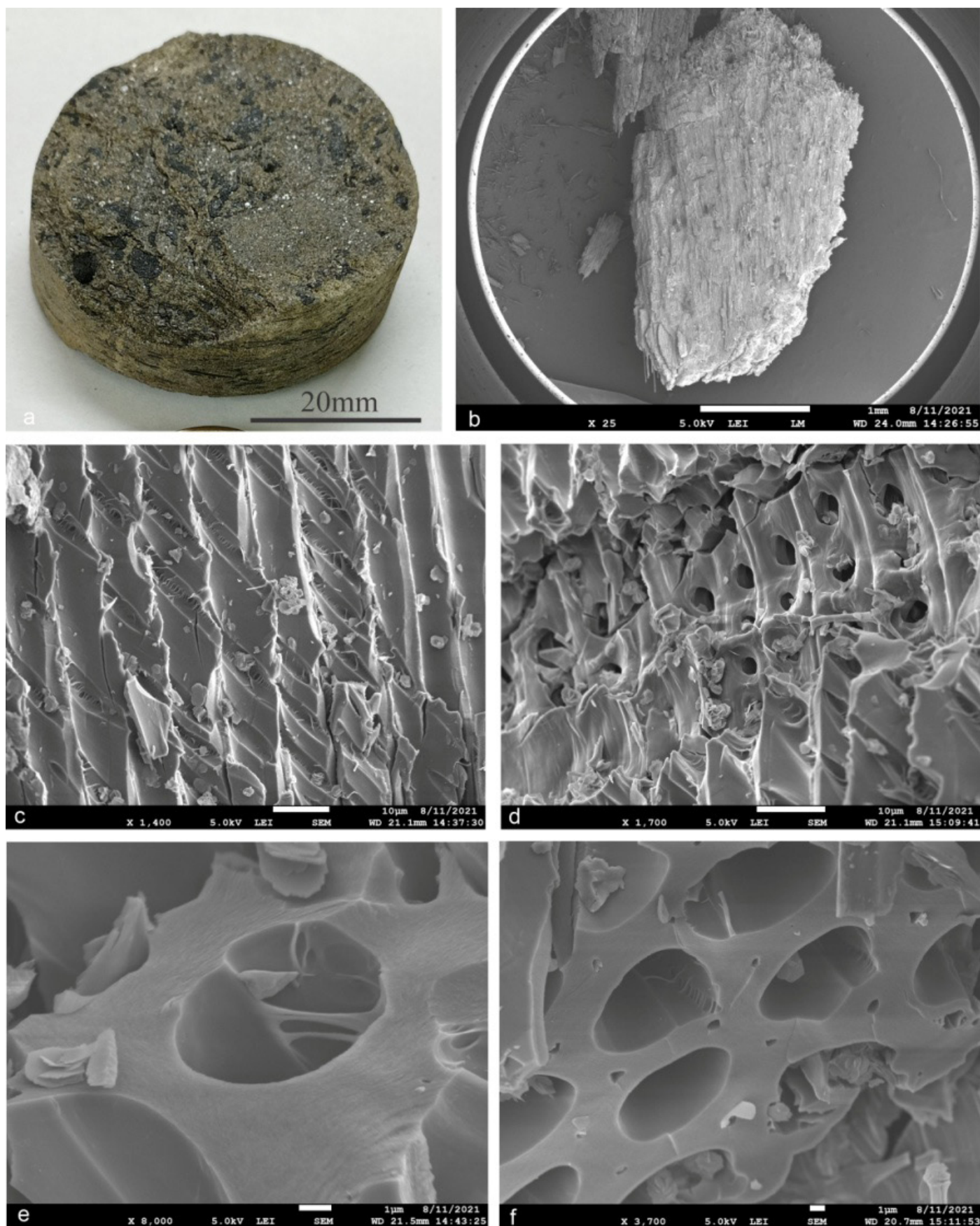


Fig. 10 - FESEM images of charcoal fragments recovered from the Cretaceous strata in the borecore RRK-1, Raniganj Coalfield. a. charcoal fragments embedded in the fine grained sandstone, b. overview of fragment, c. overview on ray in radial view, d. bordered pits on radial cell wall of tracheid e-f. Tracheids in cross-section, exhibiting homogenized cell walls and tri-angular spaces in conjunctions of tracheids.



PROJECT OUTCOME

In SCI (Science Citation Index) Journals

1. Aggarwal N & Goswami S 2024. Tectonic inferences from palynology of Permian sequences of the Godavari Coalfield, southern India. *Palynology* DOI: 10.1080/01916122.2024.2323730 (IF: 1.5).
2. Aggarwal N, Mishra D & Hazra B 2024. Study on sequence stratigraphy in the Permian sediments of terrestrial sequences within the Chintalapudi sub-basin, Godavari Coalfield, southern India: insight from palynology and geochemistry. *Environmental Earth Sciences* 83: 233. <https://doi.org/10.1007/s12665-024-11535-z> (IF: 2.8).
3. Choudhuri A, Mandal S, Bumby A & Pillai SSK 2023. Glacial sedimentation in Northern Gondwana: insights from the Talchir Formation, Manendragarh, India. *Geological Magazine*: 1-13 (IF: 2.3).
4. Drobnik A, Mastalerz M, Jelonek Z, Jelonek I, Adsul T, Andol'sek NM, Ardakani OH, Congo T, Dembereluren B, Donohoe BS, Douds A, Flores D, Ganzorig R, Ghosh S, Gize A, Goncalves PA, Hackley P, Hatcherian J, Hower JC, Kalaitzidis S, Kędzior S, Knowles W, Kus J, Lis K, Lis G, Bei Liu, Luo Q, Du M, Mishra D, Mugerwa MMT, Nedzweckas JL, O'Keefe JMK, Park J, Pearson R, Petersen HI, Reyes J, Ribeiro J, Rosa-Rodriguez G, Valentine PSB, Varma AK, Wojtaszek-Kalaitzidi M, Xu Z, Zdravkov A & Ziemianin K 2023. Inter-laboratory study: Testing reproducibility of solid biofuels component identification using reflected light microscopy. *International Journal of Coal Geology* 277: 10433 (IF: 5.6).
5. Govind N, Sahoo M, Pillai SSK, & Sahu SK 2023. IPSPD: e-repository of Permian seeds from Indian Lower Gondwana. *Acta Palaeobotanica* 63(2): 151-161 (IF: 0.87).
6. Joshi H & Aggarwal N 2023. Palynology of the Upper Gondwana deposits from the Chintalapudi sub-basin, south India: Insights into age and palaeodepositional settings. *Cretaceous Research* 10.1016/j.cretres.2023.105734 (IF: 2.1).
7. Joshi H & Aggarwal N 2024. Palynological dating and incidence of the fossil Botryococcus in variable pH from the Mesozoic sediments of the Godavari Valley Coalfield, south India: insights in palaeoecology and palaeoenvironment. *Environmental Earth Sciences* 83: 218. <https://doi.org/10.1007/s12665-024-11527-z> (IF: 2.8).
8. Kavali Pauline S, DiPasquo M & Kushwaha SK 2023. Multidisciplinary analysis to interpret the palaeoclimate and depositional environment of the Late Paleozoic postglacial sediments from Wardha Basin, Maharashtra State, central India. *Journal of the Geological Society of India* 99: 635-646 (IF: 1.6).
9. Mandal S, Singh A, Banerjee S, Uddandam PR & Negi RS 2024. Linking the impact of seismicity on palaeogeographic evolution and sedimentary architecture: A case study from Middle Jurassic succession of Spiti Himalaya. *Geological Magazine*. <https://doi.org/10.1017/S0016756823000778> (IF: 2.3).
10. Murthy S, Jasper A & Uhl D 2023. Macro-charcoal as evidence for wildfire events during the Valanginian-Hauterivian and Barremian? (Rajmahal Formation, Lower Cretaceous) in the Raniganj Coalfield, West Bengal. *Cretaceous Research* 151: 105625 (IF: 2.1).
11. Murthy S, Saxena A, Khnagar R, Pillai SSK, Uhl D, Singh VP, Gupta S & Borkar N 2023. Palynofloristics and wildfire evidence from Permian deposits of the Satpura Gondwana Basin, India: a multiproxy approach. *Historical Biology* <https://doi.org/10.1080/08912963.2023.2272690> (IF: 1.4).
12. Negi RS, Singh BP & Bhargava OM 2023. Integrated sedimentological and ichnological studies of the Cambrian of the Tidong Valley, Kinnaur, its correlation with Zaskar-Spiti regions and reconstruction of the northern margin of Indian Plate. *Neues Jahrbuch für Geologie und Paläontologie - Abhandlungen* 309(1):1-18. doi: 10.1127/njgpa/2023/1141 (IF: 0.8).
13. Pillai SSK, Manoj MC, Mathews RP, Murthy S, Sahoo M, Saxena A, Sharma A, Pradhan S & Kumar S 2023. Lower Permian Gondwana sequence of Rajhara, (Daltonganj Coalfield), Damodar Basin, India: floristic and geochemical records and their implications on marine incursions and depositional environment. *Environmental Geochemistry and Health* 45(10): 6923-6953 (IF: 4.898).

Refereed Non-SCI Journals

1. Murthy S, Agnihotri D, Uhl D, Jasper A & Singh RK 2023. Palaeoenvironmental and stratigraphical implications of the palynoflora and macro-charcoal from the early Permian of the Chuperbhita Coalfield, Rajmahal Basin, Jharkhand, India. *Journal of Palaeosciences* 72(2): 141-151. 10.54991/jop.2023.1865.

General Articles/Reports/Database Published

1. मिश्रा ए.के. एवं अग्रिहोत्री डी. 2023. अरुणाचल प्रदेश: इतिहास, भौगोलिक विशेषताएं तथा भूगर्भीय क्षेत्रीय भ्रमण. पुराविज्ञान स्मारिका, अंक-2: 40-43.



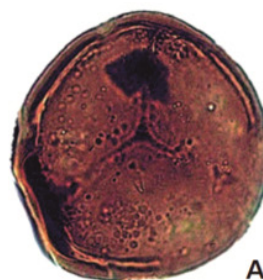
Punctatisporites gretensis across Gondwana



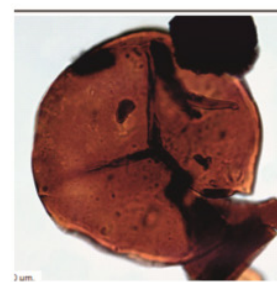
Paganzo Basin
Argentina



Collie Basin
W. Australia



Karoo Basin
South Africa



Parana Basin
Brazil

Callumispora gretensis from India

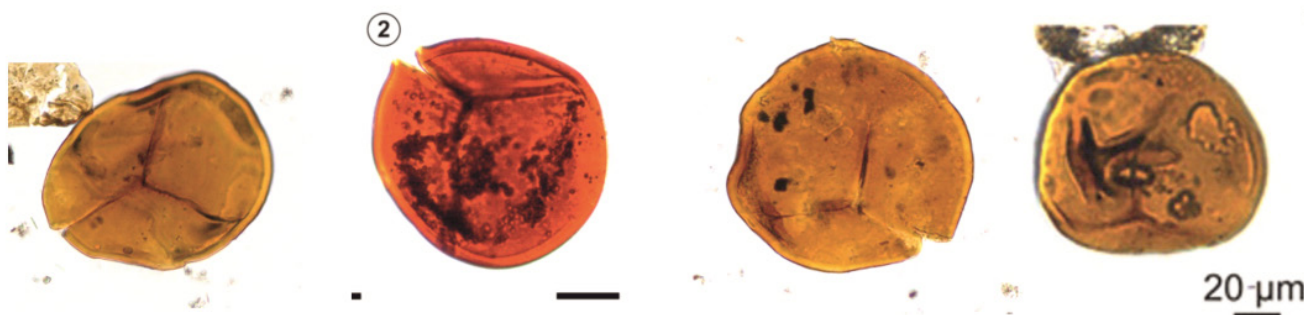


Fig. SP 2.1 - Comparison of *Punctatisporites gretensis* across Gondwana with *Callumispora gretensis* from India.

Publication as an outcome of Sponsored Project

- Gupta S, Saxena A, Shabbar H, Murthy S, Singh KJ & Bali R 2023. First record of late Devonian-early Carboniferous palynoflora from the Lipak Formation, Spiti Basin, Tethyan Himalaya, India, and their biostratigraphic implications. *Journal of the Palaeontological Society of India* 68(1): 22–41 (IF: 0.63).
- Singh YP, Verma P, Singh A & Bali R 2023. Early Miocene (Burdigalian) dinoflagellate cysts from the Kerala Basin, southwest India: indicators of marine incursion at the onset of the Mid-Miocene Climate Optimum (MMCO). *Journal of the Geological Society of India* 99: 357-369 (IF: 1.466).

SPONSORED PROJECTS (SP) & COLLABORATIVE PROJECTS (CP)

Publications other than Project Work

- Pradhan S, Goswami S, Aggarwal N, Mathews RP, Manoj MC, Pillai SSK & Pradhan SS 2023. Integrative study of Permian coal bearing horizons: biostratigraphy, palaeovegetation, and palaeoclimate in the South Karanpura Basin. *Environmental Geochemistry and Health* 45: 6985–7010. <https://doi.org/10.1007/s10653-023-01701-w> (IF: 4.2).
- Singh A, Jain S, Benzaggagh M, Schweigert G, Salamon MA & Mulugeta M 2023. Late Tithonian nannofossils from Dejen area, the Blue Nile Basin, central western Ethiopia. *Palaeoworld* 32: 470–480. doi.org/10.1016/j.palwor.2022.10.003 (IF: 2.717).

SP 2.1

Re-evaluation of late Paleozoic spores and pollen from Indian Gondwana sequences to resolve gaps in global correlation and palaeobiogeography [Sponsored by MoES, Project No: MoES/P.O. (Geo)/211/2019, w.e.f. October 2022]

Investigators: Pauline Sabina Kavali (PI) & Runcie Paul Mathews (Co-PI)

Palynological studies in the Gondwana sequences of India is now witnessing an unparalleled and explosive increase in the number of new names which is a consequence of lack of uniformity in identification and designation, ultimately leading to questionable stratigraphic ranges.

Thus there exists a problem concerning the appropriate function of scientific names and their relation to systems of classification. But accurate stratigraphic conclusions depend upon accurate identification. It is therefore necessary to attempt to supply some common denominator of systematic thought to bring about consistency. Works are in progress towards this goal.

Here we are showing the results of the comparative studies of one genus *Callumispora* and *Punctatisporites* and re-assignment of the taxonomic status of *Callumispora* Bharadwaj and Srivastava 1969 as junior synonym of *Punctatisporites* (Ibrahim) Schopf, *et al.* 1944 (Fig. SP 2.1). From the comparison of the diagnoses of both, it is apparent that *Callumispora* (Bharadwaj & Tiwari, 1969) was erected as a new genus different from *Punctatisporites* on the grounds that it bears an infrapunctate to laevigate exine. But a critical review of the two under optical light microscope, confocal and scanning electron microscope reveals that structure of the exine is variable from laevigate to punctate to intrapunctate and therefore is of specific importance. And also the thickness of the exine is variable which is also species specific. While both are inevitably characterized by circular to roundly triangular shape with trilete mark and therefore are of generic significance which characterizes both *Punctatisporites* and *Callumispora*. Therefore *Callumispora* Bharadwaj and Srivastava 1969 is here considered as junior synonym of *Punctatisporites* by rule of priority.

CP 2.1 **Neha Aggarwal and Divya Mishra** [Prof. Shreerup Goswami, Utkal University, Bhubaneswar, Odisha]

Permian deposits in the Indian peninsula are renowned for their coal resources, attracting global interest for their hydrocarbon generation potential. This study aims to assess the late Artinskian-Kungurian sediments in the South Karanpura Coalfield through an integrated approach, combining megaflora, palynology and geochemistry. The analysis reveals diverse environmental settings, ranging from anoxic to oxic depositional environments with fluctuating water levels influenced by terrestrial inputs. The study concludes to better option of hydrocarbon generation in the eastern part of S. Karanpura Coalfield in comparison to northern part. These findings enhance the understanding of hydrocarbon generation capacity in coal formations, informing resource assessment and exploration strategies globally.

CP 2.2 **Neelam Das** [Dr. Srikantha Murthy and Mr. Raj Kumar, BSIP, Lucknow]

Bhadasar Ridge Section of the Bhadasar Formation in the Jaisalmer Basin, western India, was studied integrating palynology and palyno-facies. The

palynomorphs recovered comprise 10 genera and 24 species. The palynoassemblage of the studied section is characterized by the plant group Coniferales and are the dominant component (89.4%) of the total assemblage mainly represented by the genus *Callialasporites* (1.33-22.67%), *Araucariacites* (4-20%), *Cupressacites* (0-4%), *Microcachryidites* (1.33%), *Classopollis* (2.67%), *Podocarpidites* (1.33%) and *Pityosporites* (0-2.67%). The other groups of the assemblage are Ginkgoales - *Ginkgoretectina* (1.33-4.00%), Ephedrales - *Monosulcites* (0-1.33%). Pteridophytes are represented by the rare occurrence of *Todisporite scrassus* (0-4%) which belongs to filicales. The palynomorphs obtained from this section do not indicate any precise stratigraphical importance because most of them are long ranging forms. But the species *Callialasporites monoala sporus*, *C. trilobatus*, *C. dampieri*, *C. rimalis*, *C. discoidalis* and *C. segmentatus* have a wide distribution in the Jurassic and Cretaceous sediments.

OTHER ACADEMIC WORKS

Research Papers Presented

1. Negi RS - The Cambrian clastic sediments from the Tidong Valley (Kinnaur), Himachal Himalaya: Geochemical evidence for Continental Island-Arc type magmatism along the Northern Margin of Indian Plate. 39th Convention of the Indian Association of Sedimentologists & International Conference on "Voyage of Sedimentology from the Mountains to the Oceans: An Innovative Trajectory" at the Department of Earth Sciences, Annamalai University, Tamil Nadu, India, during December 6-8, 2023: 177.
2. Mandal S - Altered carbon cycle and coupled geochemical pattern in Maastrichtian Lameta Formation: A record of Deccan impact on infratrappean sequence of K-Pg. International Conference: Deccanext at Savitribai Phule Pune University during October 1- 5, 2023: 61.
3. Mandal S - A review on the compositional evolution of glauconite from 1.7 to 0.9 Ga record of Vindhyan Basin. Vindhyan Supergroup: Recent Advances, Challenges & Opportunities (VISOP) at Geological Survey of India (Northern Region, India) on October 18, 2023: 1.
4. Mandal S - Environmental significance of seismite and tsanamite- the key signature for sedimentary environment and tectonics: A study from Proterozoic Vindhyan Basin, India. 35th Convention of Indian Association of Sedimentologists & International Conference on "Voyage of Sedimentology from the Mountains to the Oceans: An Innovative Trajectory" at



PH.D. PROGRAMMES

	Suyash Gupta (2018). Floristic evolution and biodiversity in the Late Palaeozoic sequences of Spiti Himalayas: palaeoenvironmental and palaeogeographical implications, under the supervision of Anju Saxena (BSIP) and R. Bali (LU), registered with Lucknow University, Lucknow. Status: Awarded (November 2023).
	Raj Kumar (2016). Palaeontological record from the Mesozoic sediment of the Jaisalmer Basin, Rajasthan: biostratigraphic, palaeobiogeographic and palaeoclimatic implications, under the supervision of Neelam Das (BSIP) and Bindhyachal Pandey (BHU) registered with Banaras Hindu University, Status: Submitted.
	Nazim Deori (2019). High resolution biostratigraphy and depositional environment of Cenozoic succession of Kachchh Basin, western India, Gujarat, under the supervision of Abha Singh (BSIP) , J.M. Patel, RR Lalan College, Bhuj, Kachchh and M.G. Thakkar, KSKV, Kachchh University, registered with K.S.K.V. Kachchh University. Status: In progress.
	Alok Kumar Mishra (2020). Floristic changes in late Palaeozoic sediments of northeast India: implications in biostratigraphy and palaeoecology, under the supervision of Deepa Agnihotri (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In progress.
	Deveshwar Prakash Mishra (2019). Biozonation and palaeoclimatic reconstruction of Permo-Triassic sediments from Talchir Coalfield, Mahanadi Basin, Odisha, India, under the supervision of Srikanta Murthy (BSIP) and Bindhyachal Pandey (BHU), registered with Department of Geology, Banaras Hindu University, Varanasi. Status: In progress.
	Suraj Kumar (2022). Phases and Pathway of marine incursion and vegetation dynamics of Gondwana sediments from Eastern India: Biological and Geochemical perspectives, under the supervision of S. Suresh Kumar Pillai (BSIP) and Runcie Paul Mathews (BSIP) registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad). Status: In progress.
	Ayushi Mishra (2023). Integrated palynological and sedimentological studies of the late Paleozoic sediments of Damodar Basin to resolve gaps in global correlation and palaeobiogeography, under the supervision of Pauline Sabina Kavali (BSIP) and Umakant Shukla (BHU) registered with Department of Geology, Banaras Hindu University, Varanasi. Status: In-progress.
	Anita Chatteraj (2022). Palaeofloral diversity of Glossopteris flora and Palaeoclimatic significance of Permian Period in Raniganj Coalfield, Damodar Basin, (West Bengal) India, under the supervision of S. Suresh Kumar Pillai (BSIP) and Sandip Mazumder, registered with Kazi Nazrul University. Status: In-progress.
	Sabera Khatoon (2023). Study on event stratigraphy in the Permian sediments of terrestrial sequences within the Godavari Coalfield, Southern India, under the supervision of Neha Aggarwal (BSIP) registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. December, 2023. Status: In Progress.

Department of Earth Sciences, Annamalai University during December 6-8, 2023: 70.

- Pillai SSK - Rajmahal Hills: An Important Geodiversity and Geoheritage Home of India: Keynote lecture at National Seminar organised under the aegis of Sidhu Kanhu Murmu University, Dumka and District Authority of Sahibganj on 11th - 12th April, 2023.
- Pillai SSK- Lower Permian Gondwana sequence of Rajhara (Daltonganj Coalfield), Damodar Basin, India: floristic and geochemical records and their implications on marine ingressions and depositional environment. 39th Convention of the Indian Association of Sedimentologists & International Conference on

“Voyage of Sedimentology from the Mountains to the Oceans: An Innovative Trajectory” at the Department of Earth Sciences, Annamalai University, Tamil Nadu, India, during December 6-8, 2023: 177.

- Saxena A - Floral diversity and depositional environment of early Permian sequences of Chirimiri Coalfield, Son Basin, India. 39th Convention of the Indian Association of Sedimentologists & International Conference on “Voyage of Sedimentology from the Mountains to the Oceans: An Innovative Trajectory” at the Department of Earth Sciences, Annamalai University, Tamil Nadu, India, during December 6-8, 2023: 177.



8. Saxena A - Legacy and Vision of Prof. Birbal Sahni: Journey from Palaeobotany to Palaeosciences in National Seminar on Conservation of fossils and mineral resources and sustainable development of Santhal Pargana, Jharkhand organized by Sidhu Kanhu Murmu University, Dumka and District Authority of Sahibganj during 11th - 12th April, 2023.

Deputation to Conferences/Seminars/Workshops (both online and offline)

Srikanta Murthy

- Deputed to attend National Seminar on Conservation of fossils and mineral resources and sustainable development of Santhal Pargana, Jharkhand organized by Sidhu Kanhu Murmu University, Dumka and District Authority of Sahibganj during April 11-12, 2023

RS Negi

- Deputed to attend the 39th Convention of the Indian Association of Sedimentologists & International Conference on «Voyage of Sedimentology from the Mountains to the Oceans: An Innovative Trajectory» at the Department of Earth Sciences, Annamalai University, Tamil Nadu, India, during December 6-8, 2023.

SSK Pillai

- Deputed to attend Indian International Science Festival 2023 at DBT THSTI-RCB Campus, NCR Biotech Science cluster, Faridabad, Haryana during January 17-20, 2024.
- Deputed to attend the 39th Convention of the Indian Association of Sedimentologists & International Conference on «Voyage of Sedimentology from the Mountains to the Oceans: An Innovative Trajectory» at the Department of Earth Sciences, Annamalai University, Tamil Nadu, India, during December 6-8, 2023.
- Deputed to attend National Seminar on Conservation of fossils and mineral resources and sustainable development of Santhal Pargana, Jharkhand organized by Sidhu Kanhu Murmu University, Dumka and District Authority of Sahibganj during April 11-12, 2023.

Anju Saxena

- Deputed to attend the 39th Convention of the Indian Association of Sedimentologists & International Conference on «Voyage of Sedimentology from the

Mountains to the Oceans: An Innovative Trajectory» at the Department of Earth Sciences, Annamalai University, Tamil Nadu, India, during December 6-8, 2023.

- Deputed to attend National Seminar on Conservation of fossils and mineral resources and sustainable development of Santhal Pargana, Jharkhand organized by Sidhu Kanhu Murmu University, Dumka and District Authority of Sahibganj during 11th - 12th April 2023

Lectures delivered

SSK Pillai

- Delivered lecture entitled “Fossil and its importance” at Botany Department, Dhurba Chand Halder College, Dakshin Barasat, 24 Pargana (south). West Bengal, November 3, 2023.

ACCOLADES RECEIVED

Ranveer S. Negi

- Invited as Guest of Honour, at Greenland Public School, Lucknow, to judge and felicitate the students during an Intra-school Science Exhibition to commemorate the National Science Day 2024.

SSK Pillai

- BSIP team is developing the Marine Fossil Park at Manendragarh, Chhattisgarh. The work is under progress.

REPRESENTATION IN COMMITTEES/BOARD

Anju Saxena

- Associate Editor – Journal of the Palaeontological Society of India, SAGE Publications
- Editor – Journal ‘Geophytology’, The Palaeobotanical Society, India

Deepa Agnihotri

- Assistant Editor – Journal of Palaeosciences

Neha Aggarwal

- Joint Secretary – The Palaeobotanical Society, India



Project 3: Pre- and Post-Collision biotic turnover(s) and climate change(s) pertaining to India (Terminal Cretaceous-Cenozoic)

COORDINATOR: HUKAM SINGH (SCIENTIST E)

CO-COORDINATOR: POONAM VERMA (SCIENTIST E)

OBJECTIVES

- *Bioticturnover(s) K-Pg transition: palaeobiodiversity and Palaeobiogeography*
- *Biostratigraphy, age correlation, Sequence biostratigraphy and source rock characterisation of lignite-bearing sequences of western India*
- *Origin, evolution, Palaeobiodiversity, extinction, and Palaeobiogeographic aspects of Cenozoic biota of India*
- *Quantification of late Cretaceous to Cenozoic climate and monsoon evolution of India based on biotic and abiotic proxies.*

PREAMBLE

The Indian Plate separated from the Gondwana supercontinent around 90 million years ago. As it moved northward, it experienced significant climate and palaeobiogeographic changes before eventually colliding with Eurasia Plate during the Paleogene Period. During its northward voyage, Indian Plate experienced large-scale volcanic activity as a consequence of passing over the Reunion Hotspot. The Volcano-Sedimentary Successions (DVSS) deposited during this period provide a significant

source of fossil biota dating back to approximately 66 million years ago. To comprehend the timing(s) and extent of this catastrophic event, it is crucial to establish the chronology of the DVSS. It is also important for understanding the biotic turnovers across the Cretaceous–Paleogene (K–Pg) transition with the help of data on fossil flora and fauna from the DVSS.

Furthermore, the global extreme climate events during the Paleogene (e.g., PETM at ~56 Ma; ETM2 at ~53.7 Ma, MECO at ~40 Ma and other small events) are considered as the important analogues to understand the effect(s) of warming in tropics. Efforts are underway to analyze palaeoenvironmental, palaeoecological repercussions and their impact on the then biota. The biostratigraphical data is important to establish the time framework to the Paleogene lignite-associated sedimentary successions of western India and palaeontological data is helpful in understanding the origin, early evolution and palaeogeographical distribution of Paleogene biota. The Amber from these deposits preserves a pristine palaeobiota that provide insight to all the spheres in the ecosystem. Furthermore, the estimation of change in the vegetation patterns and faunal diversity and its link(s) to climate change at the end of the Paleogene and during the Neogene intervals is also being done. In addition, climate parameters are being quantified to understand the evolution of monsoons and modernisation over the Indian subcontinent.



1st Row (L to R): Ansuya Bhandari, Poonam Verma, Hukam Singh, Anumeha Shukla, Adrita Choudhuri, Shreya Mishra; **2nd Row (L to R):** Mohd. Arif, Suman Sarkar, Vivesh Vir Kapur, Gaurav Srivastava, Runcie Paul Mathews Prem Raj Uddandam

The Project 3 includes a total of four components that aim to study the Indian subcontinent's biota in the context of their origin, evolution, palaeobiogeographic history and the palaeoenvironmental change(s) from the late Cretaceous to Cenozoic (67 Ma to 2.5 Ma). For that significant fossil data on flora and fauna (mega and micro) and other proxies such as inorganic and organic geochemistry, sedimentology, and stratigraphy (-bio, -chemo, and magneto-) are being utilised.

PERSONNEL INVOLVED

Team Members: Gaurav Srivastava (Scientist E), Anumeha Shukla (Scientist E), Vivesh Vir Kapur (Scientist D), Runcie P. Mathews (Scientist D), Md. Arif (Scientist C), Ansuya Bhandari (Scientist C), Shreya Mishra (Scientist B), Prem Raj Uddandam (Scientist B), Adrita Choudhuri (Scientist B), Suman Sarkar (Scientist B), Divya Kumari Mishra (Scientist B)

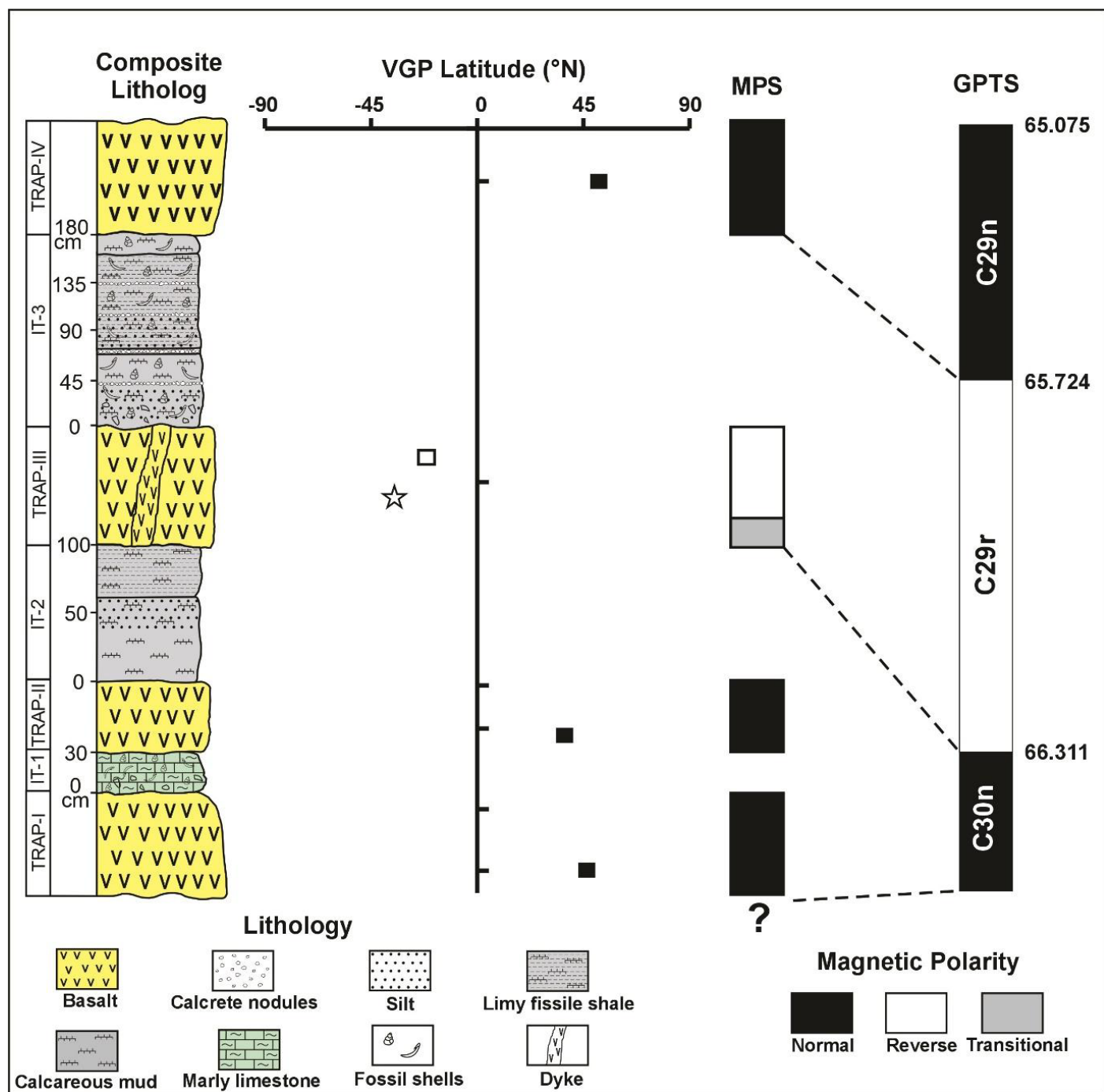


Fig. 1 - Magnetostratigraphic results of associated basaltic traps of Gujri-Dugni Intertrappean Section (Malwa subprovince) plotted as VGP latitude in °N and its correlation to Chrons C30n, C29r, and C29n of the GPTS (after Gradstein et al., 2012; Sprain et al., 2018). Solid (open) squares denotes the VGP Latitude for the associated basaltic traps; open star denotes the VGP Latitude for the intruded dyke in Trap-III, respectively.

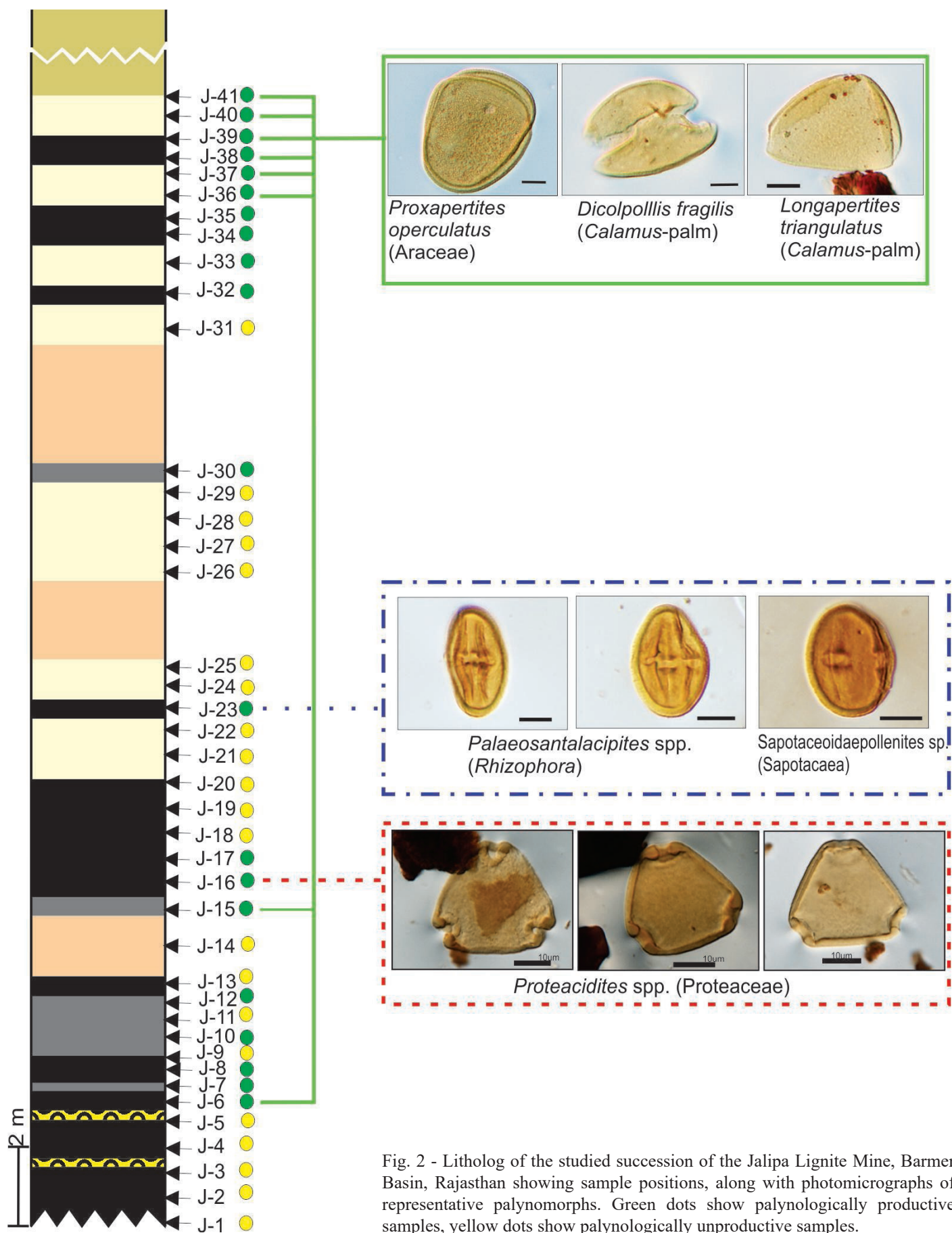


Fig. 2 - Litholog of the studied succession of the Jalipa Lignite Mine, Barmer Basin, Rajasthan showing sample positions, along with photomicrographs of representative palynomorphs. Green dots show palynologically productive samples, yellow dots show palynologically unproductive samples.

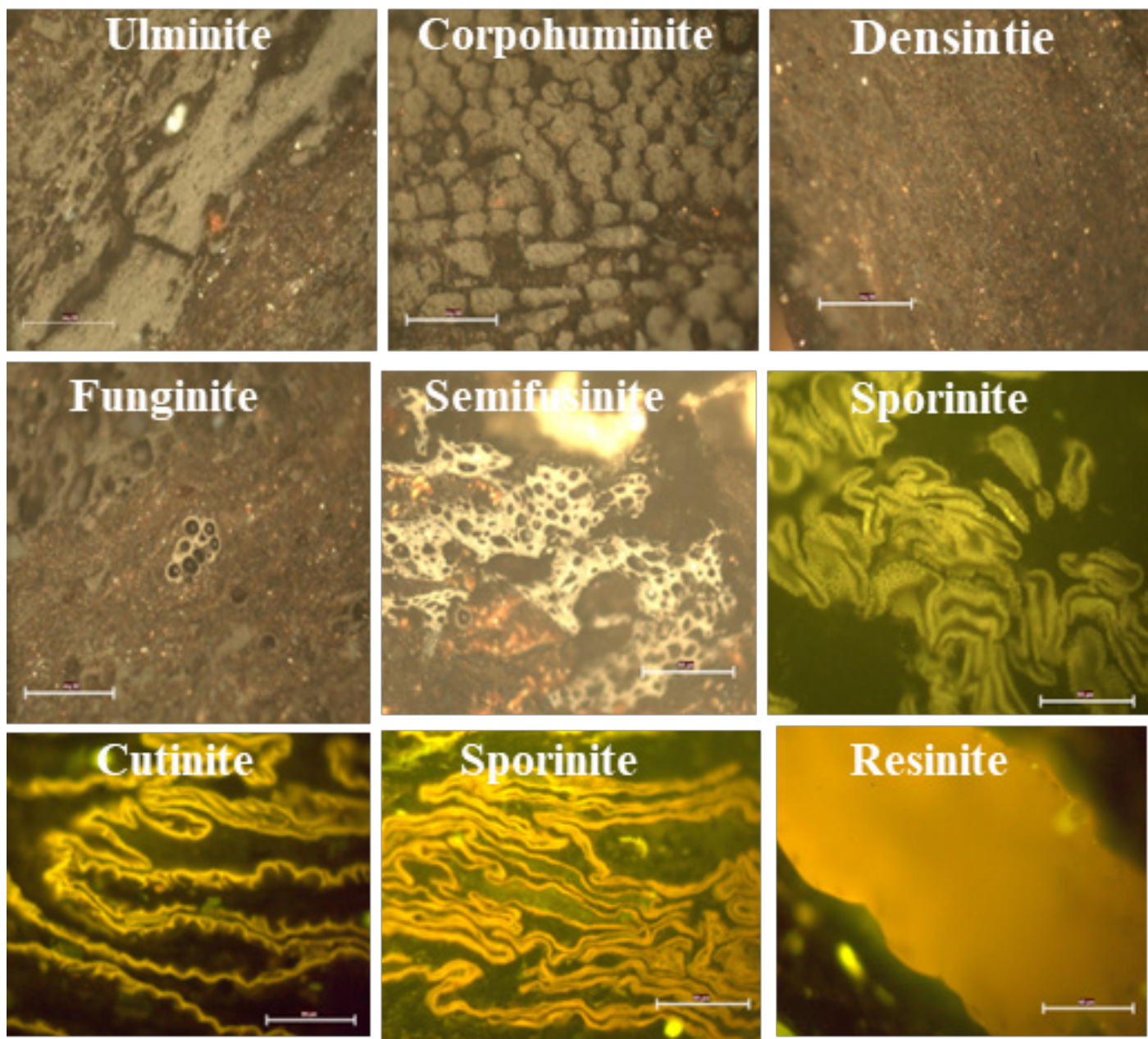


Fig. 3 - Representative photomicrographs of macerals in the Jalipa Lignite, Barmer Basin, Rajasthan.

Collaborators: Abha Singh (Scientist D), Arvind Kumar Singh (Scientist C)

Technical Support Member: Archana Sonker (Technical Assistant A)

Research Scholars: Harshita Bhatia, Kajal Chandra, Samiksha Shukla, Sarvendra Pratap Singh, Ramanand Sagar, Sadanand Pathak, Rimpay Chetia, Satendra Kumar Gupta

SIGNIFICANT FINDINGS

The Gujri-Dugni Intertrappean Succession is unique in its constitution due to the occurrence of three Intertrappean sedimentary deposits (namely IT-1, IT-2, and IT-3) associated with four basaltic traps with a dyke intruded

in third basaltic trap (namely Trap-I, Trap-II, Trap-III, and Trap-IV) in a continuous vertical stratigraphic succession. For determining the magnetochrons of associated basaltic traps and intruded dyke, a total of 300 basalt specimens were subjected to stepwise Alternating Field (AF) demagnetisation and 130 specimens were stepwise thermal demagnetised. The palaeomagnetic data of associated basaltic traps reveal the presence of normal, reverse, and normal polarity sequence spanning the magnetochrons C30n-C29r-C29n, respectively, corresponding to the age duration of 67.2–65.1 Ma (late Maastrichtian to early Danian) (Fig. 1). Also, of importance, is that the thin lava pile at the base of Trap-III contains basaltic flow with a transitional magnetic polarity suggesting that this flow was erupted during the period while the geomagnetic field was reversing. For the dyke intruded in the upper part of basaltic Trap-III, the palaeomagnetic data reveal

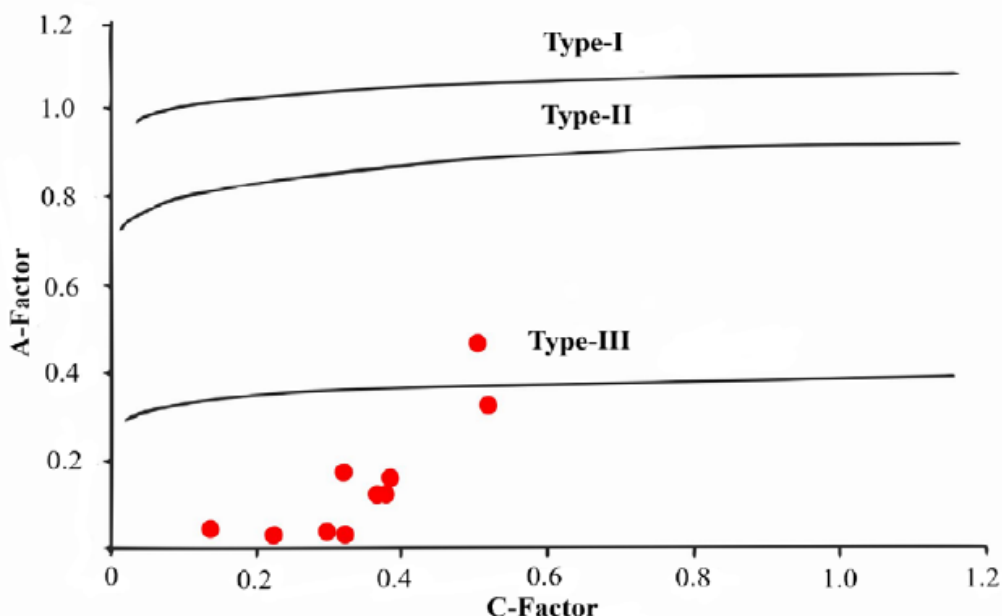


Fig. 4 - A-Factor vs. C-Factor plot showing the kerogen type present in the Giral Shale sample, Rajasthan.

the presence of reverse polarity, which corresponds to Chron C29r, and is most similar to the mean characteristic remnant magnetisation (ChRM) direction of the upper lava flow of Trap-III, thus, suggesting a positive baked contact test. Using the obtained mean ChRM directions of associated four basalt traps and intruded dyke, the virtual geomagnetic poles (VGPs) were calculated. The VGP latitudes of each of the basaltic trap along with the intruded dyke are plotted to define the magnetic polarity stratigraphy (MPS) of the Gujri-Dugni Intertrappean Section and have been correlated with the geomagnetic polarity time scale (GPTS) after Gradstein *et al.* (2012) and the updated calibration after Sprain *et al.* (2018) (Fig.1).

Well-preserved and moderately diverse palynological assemblage has been recovered from sediment samples of Jalipa Lignite Mine Succession, Barmer Basin, Rajasthan. The palynological assemblage was found dominated by sporomorphs of angiospermous origin. The angiosperm population of the palynoflora at several levels (Fig. 2) is dominated by the Zamiculcadoideae subfamily of Araceae (*Proxapertites* spp.) indicates presence of brackish estuarine palaeoenvironments. The pollen taxa such as *Albertipollenites* sp. (*Dipterocarpus*), *Lakiapollis* sp. and *Dermatobrevicollporites* sp., (*Durio*), *Rhoipites* sp. (*Rhoea*), *Perforicollpites* sp. (*Convolvus*), *Ctenolophonidites* spp. (*Ctenolophon*) and *Intrareticulatus brevis* (*Gunnera*) indicate the widespread of the tropical rain forests in the hinterland that flourished under the then warm and humid climate. A level in the middle of the succession is found over dominated by mangrove pollen (Fig. 2) indicating increase in tidal influence probably due to relative rise in sea water in the depositional basin. The occurrences of

Proteaceae pollen (*Proteacidites* spp.) along with sporadic occurrence gymnosperm pollen (*Araucariacites australis*, *Podocarpidites* sp., *Inaperturopollenites* sp.) probably indicate influx from the nearby upland flora.

Geochemical and visual kerogen characterisation has been performed on lignite and carbonaceous clay samples from Jalipa lignite-bearing sequence of the Barmer Basin, Rajasthan (Fig. 3). Maceral analysis reveals the dominance of huminite macerals (avg. 66.36 vol.%) with subordinate liptinite macerals (avg. 16.59 vol.%). Mineral matter content is varying from 2.12 vol.% to 20.20 vol.% in these samples. Functional groups including OH, aliphatic C symmetric and asymmetric stretching, C=C, C=O shows prominent peaks. The aliphaticity showed increasing trend with respect to the liptinite composition. The kerogen is identified to a mix of type III and II. The HI and liptinite content showed a positive correlation (r^2 : 0.86) showing the relationship between maceral composition and the hydrocarbon potential. T_{max} suppression is clearly evident from the negative correlation (r^2 : 0.98) with the liptinite content. Overall characteristics suggest that these samples qualify as clean coal with high suitability for liquefaction purposes. The general consistency in the variation of huminite and inertinite macerals from bottom to top of the section suggests more methane sorption capacity at the lower and upper seams of the studied section.

From the above results, it can be discussed that the vitrinite reflectance of the shale samples from the Giral Lignite Mine shows average reflectance varying in-between 0.228 to 0.268 (VRo) suggests that the shale is thermally immature, and has low fixed carbon (FC). Further, the

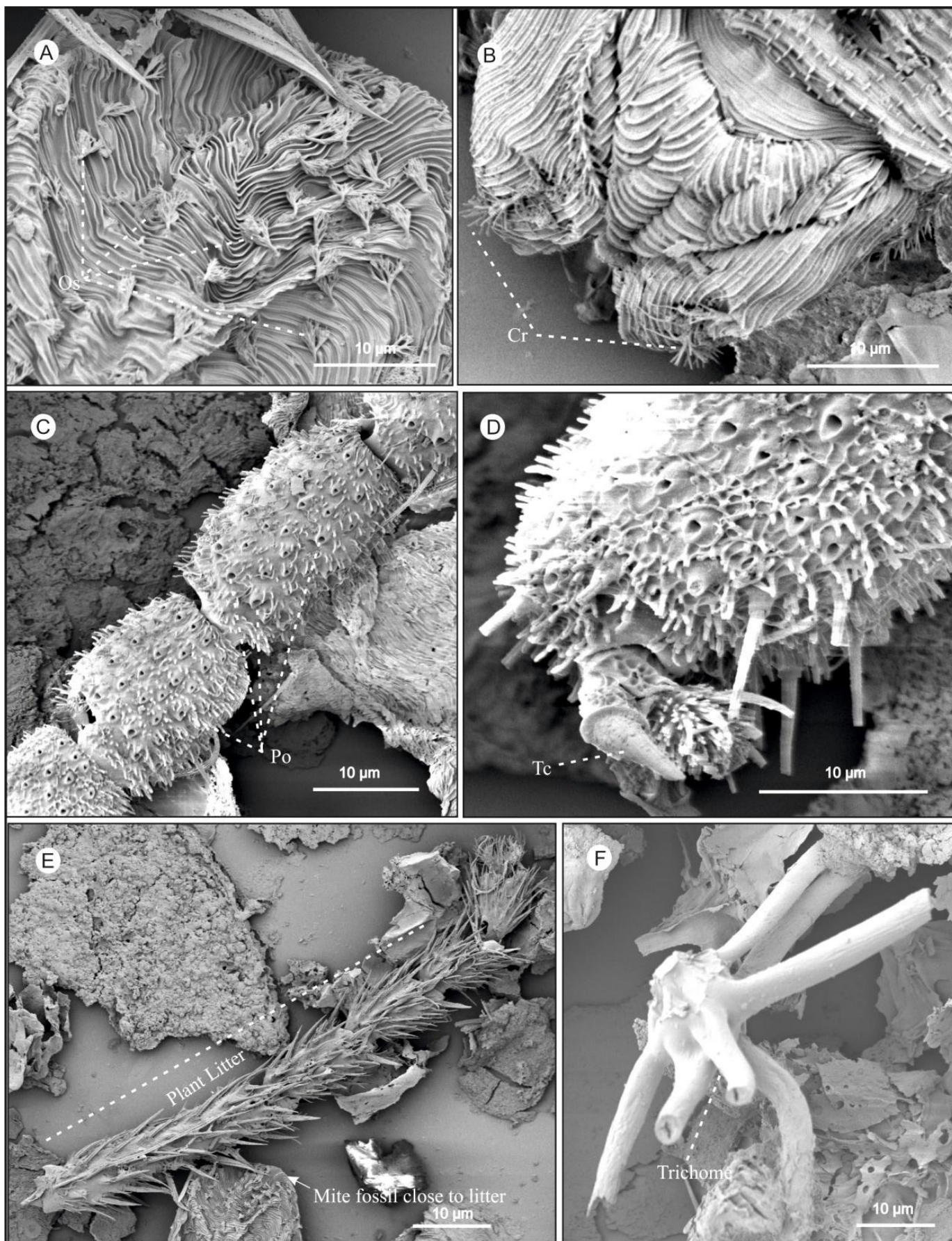


Fig. 5 - SEM images of characteristic features of *Sarcoptes kutchensis*, extracted from Kutch amber (BSIP Museum Number 42236); (A) micro-foveolate dorsal surface with irregular striations and sensory opisthosomal suckers (OS); (B) magnified view of the capitulum with caruncles (Cr) on the unsegmented palps; (C and D) magnified view of leg fragments with pore (Po) short and stout setae and curved tarsal claw (TC); (E) Mite fossil in close proximity to plant litter; (F) Trichome (plant remain).



Fig. 6 - *Geogaranya valiyaensis* n. gen., n. sp. ♂, (dorsal view), BSIP Museum Number- 41982.

presence of a large amount of mineral matter especially the pyrite represents the chances of marine input within the basin from where the shale samples were collected. The values of the A-factor and C-factor are plotted on the Van Krevelen Diagram (Fig. 4). According to the data generated after the analysis of the samples, they mostly comprised the area around Type III kerogen. By considering the data obtained from the GC-MS of Giral Shale shows low Pr/Ph ratio which oxic-anoxic conditions. The ACL value suggests that the formation took place under a wet-dry environment. Here the Paq value is low so it represents emergent macrophytes. Further, the C23/C29 ratio represents a terrestrial condition.

FTIR analysis of (a) Mangrol Cambay Resin, (b) Matanomadh Resin, (c) Tarkeshwar Resin, (d) Umarsar Resin, (e) Valia Resin, (f) Vastan Resin. The samples were run in FTIR setup (Agilent Cary 630 FTIR) through transmission method. The studied fossil resins samples for the FTIR analysis, show the common peaks at various wave number in which aliphatic C-H stretching 2953 cm⁻¹, C=O stretching, aliphatic C-H bending 1451-1460 cm⁻¹, aliphatic CH₃ deformation 1377 cm⁻¹, aromatic C-o 1162 cm⁻¹ and aliphatic C-O 1032-1050 cm⁻¹ found. Kerogen is important because it serves as the precursor to hydrocarbons, including oil and natural gas. It plays a key role in the formation of fossil fuels through a process called catagenesis. As organic matter (such as dead plants and algae) is buried and subjected to heat and pressure over millions of years, it transforms into kerogen and eventually into hydrocarbons. The A-C factor of fossil resins obtained are 0.8-0.9 respectively showing that it is type II kerogen.

The detailed palynological investigation of 65 samples of 16 m thick sedimentary succession from the Siju Formation,

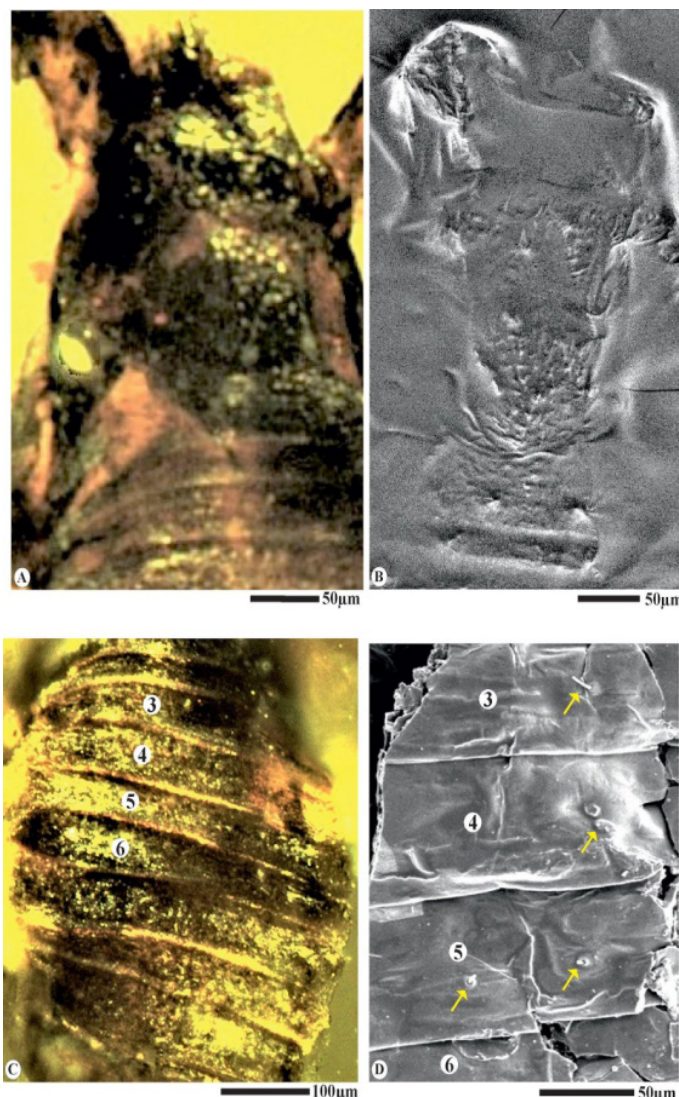


Fig. 7 - High resolution images (A and C- under stereoscope M205A, B and D- SEM images) of characteristic details of *Geogaranya valiyaensis*: (A) and (B) granular projections on chephalothoax (dorsal view), (C) and (D) tergites III to VI with lyrifissures (magnified dorsal view).

West Garo Hills, south Shillong Plateau has yielded well-preserved and diverse organic-walled dinoflagellate cysts. A total of thirty-five species belonging to nineteen genera of dinoflagellate cysts were recorded. Global biostratigraphic marker taxa such as *Heteraulacacysta porosa* was crucial to assign middle Eocene age for the studies section. In addition to dinoflagellate cysts palynofacies analysis is also carried out to decipher sea level and palaeoenvironmental changes in the studies section. Dinoflagellate cysts and palynofacies analysis reveals shallowing and increased terrigenous flux on the top of the succession during late Bartonian. Present record along with the other records from the India and Australia reveal a major transgression during late Bartonian in the Indo Pacific region known as 'Kirthar transgression'.

A significant new species of a fossil sarcoptid mite, *Sarcoptes kutchensis* n. sp., was extracted from a dissolved

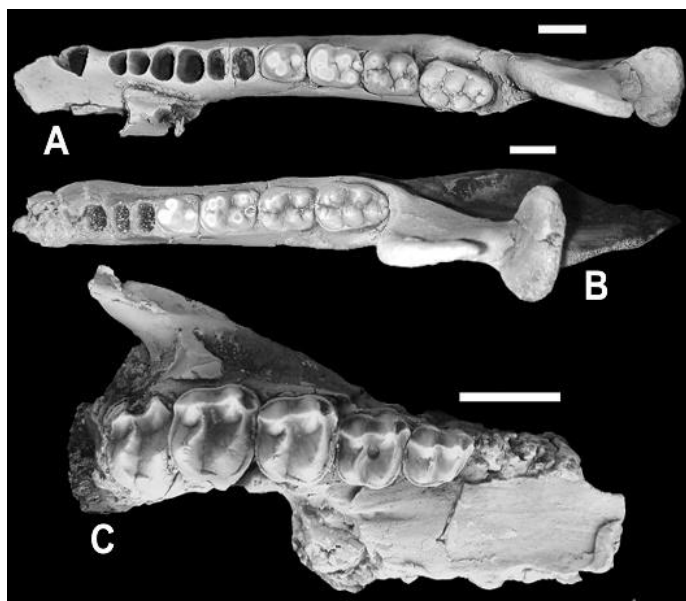


Fig. 8 - Large-sized early Eocene (~ 54.5 Ma) Cambay Shale perissodactyls. **A.** *Cambaytherium thewissi* (VLM-505), holotype right dentary with in situ p4-m3, occlusal view; **B.** *C. thewissi* (VLM-505), holotype left dentary with in situ p4-m3, occlusal view; **C** *Cambaylophus vastanensis* (VLM-760), holotype right maxillary fragment with dp3, dp4, m1, m2 and erupting m3, occlusal view. (modified after Kapur, 2020).

slab of amber, from the Umarsar Lignite Mine of the Kutch Basin (Fig. 5). The fossil is a remarkable representative of forest litter biota, well-preserved in amber and represents the oldest group of mites from the equatorially placed Eocene forest, dominated by broad-leaved Dipterocarpaceae trees and shares similar taxonomic features with the present day genus of *Sarcoptes*, Latreille, 1802. The species is recognised by dense microfoveolate striations, lack of cuticular spines on the dorsal surface with morphological resemblance to *Trixacarus*, Sellnick, 1944, particularly in terms of monodactyly. The fossil is derived from an ancient group of forest litter biota which gradually evolved to higher trophic levels including association with vertebrates. Scanning Electron Microscopy (SEM) is used to highlight diagnostic characteristics including capitulum and partially concealed legs with sensory suckers, crucial for defense against large faunal predators. There are very few instances of Eocene mites, exceptionally preserved in fossil records over time, because of their small and fragile bodies leading to poor preservation. The preservation of such delicate life forms in amber is possible due the chitin-rich and sclerotized cuticle which accounts for more than half of the total body mass. Here, we present a new species of a sarcoptid mite, *S. kutchensis* n. sp. Scanning Electron Microscopy reveals diagnostic characteristics of the fossil, including unsegmented hypostomal palpus, fused podonotal and opisthosomal shields and partially concealed legs underneath the abdomen. These features are crucial for defense against large faunal predators.

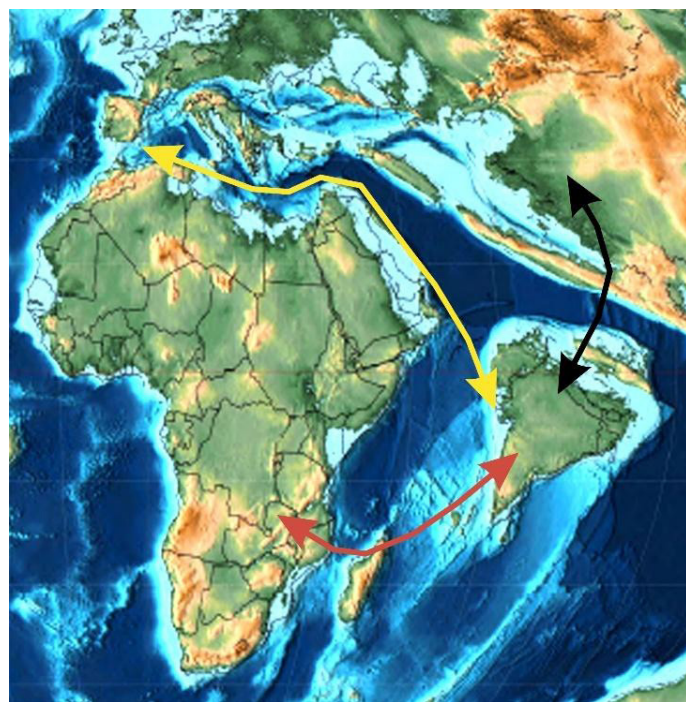


Fig. 9 - Palaeogeographic reconstruction of India during its final drift phase (~ 56 Ma) with envisaged biotic dispersal routes between India and its surrounding continents. Scenario 1: Biotic dispersals between India and Africa via Madagascar; Scenario 2: Biotic dispersals between India and Eurasia via the Kohistan-Ladakh arc system; Scenario 3: Biotic dispersals between India and North Africa-Eurasia along the shallow marine coasts of the Tethys. (Map modified after Scotese, 2013).

A new genus and species of fossil pseudoscorpion *Geogaranya valiyaensis* n. gen. n. sp. is described from the Valia Lignite Mine, Cambay Basin, Gujarat (Figs. 6 and 7). The new fossil taxon is exceptionally preserved in the early Eocene Cambay amber and is a member of the Family Geogarypidae with similar affinities to modern genus *Geogarypus* (Chamberlin, 1930) recorded from Sri Lanka, India and New Guinea. The taxon is one of the smallest known adult fossil of pseudoscorpion in amber from the Cambay Basin which adds to the bark-dwelling arthropod biodiversity identified in the Eocene amber from western India. The scanning electron microscopic (SEM)



Fig. 10 - Miocene Rodent molar from Mohand, Siwalik.



Fig. 11 - Showing recovered fossil flowers and pollen. (A) flower from the Barmer Basin, (B-K, N) flowers from the Gurha Lignite Mine, (F) showing a bud pointed by black arrow, (J) enlarged view of petal venation, (L-M) showing the fossil pollen *Rhoipites anacardioides* Ramanujam recovered from the central portion of specimen C having preserved stamens. Scale represents 1 cm for A, D, E, F, J, K, N; 0.5 cm for B, C, G, H, I; 10 μ m for L, M.

study and systematic description of *G. valiyaensis* fossil in amber represents biota belonging to a much warmer temperature during the Eocene. We also state record similar affinities of the fossil with those recorded from

the Baltic and Rovno, in support of a strong tilt towards bark-dwelling taxa. The occurrence of this early Eocene pseudoscorpion taxon in Cambay amber provide evidence for the presence of arachnid species in the vicinity of a

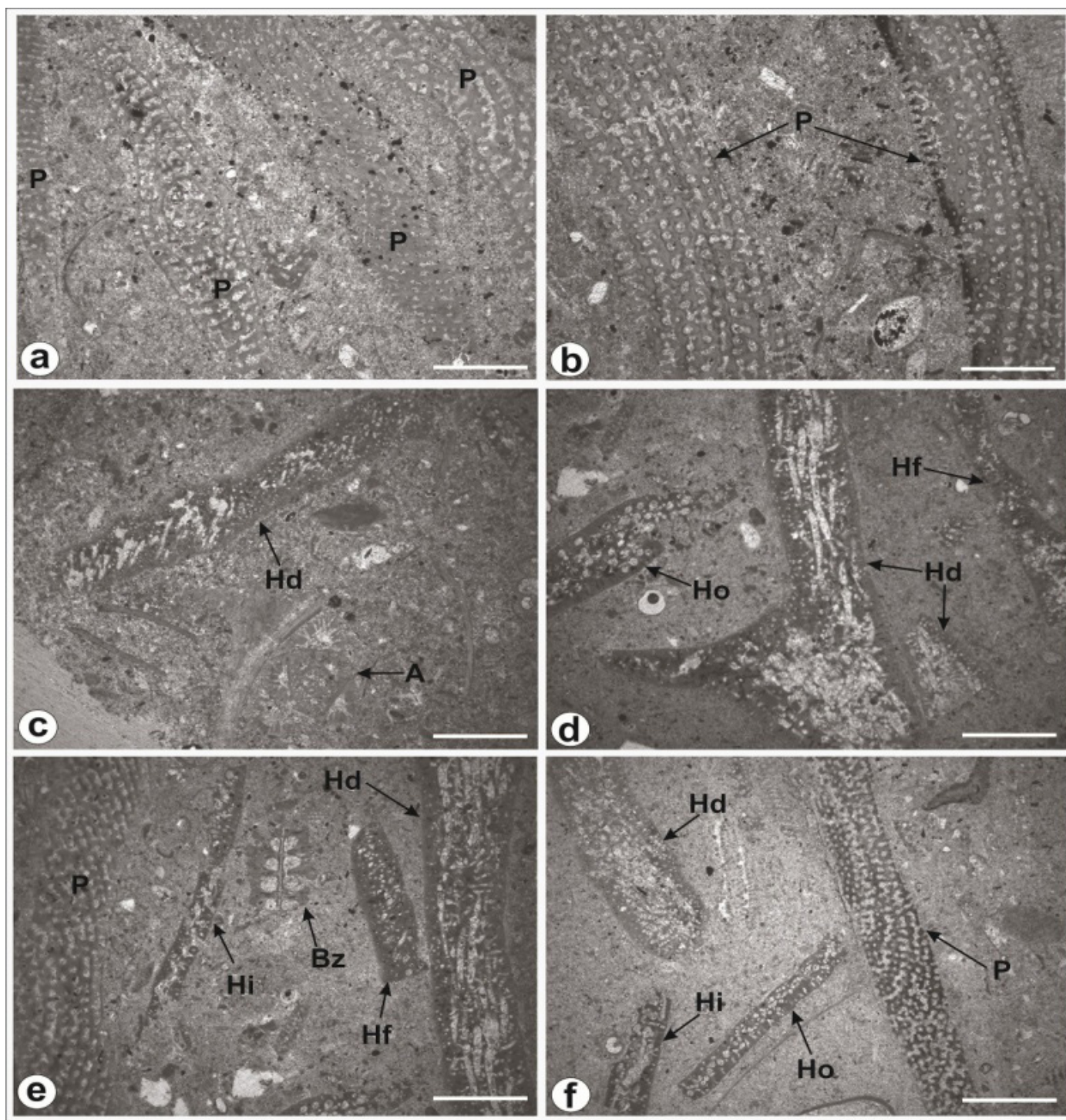


Fig. 12 - Photomicrographs of the dominant biotic components of the Quilon Limestone skeletal assemblage: (a-b) soritid foraminifera *Pseudotaberina malabarica* (P) in floatstone microfacies; (c-f) Species of *Halimeda* – *H. discoidea* (Hd), *H. fragilis* (Hf), *H. incrassata* (Hi) and *H. opuntia* (Ho) with *Pseudotaberina* (P) in e-f, *Austrotrillina* (A) in c and bryozoan fragment (Bz) in e. Scale Bars: 0.5 mm.

warm Eocene forest, with similar diversification pattern to the Eocene spiders (Dunlop *et al.*, 2018).

An overview of the Paleogene vertebrate faunal records, especially mammals, with an emphasis on research conducted within the last 5 years, i.e. from 2019 to 2023. Recent developments highlight the significance of vertebrate fossil records (particularly that of mammals) in our understanding of the origin, evolution, and historical

distributions close to the India-Eurasia docking phase. Overall, the fossil records of early Paleogene vertebrates indicate that India was a hotspot for biodiversity for several orders of terrestrial (such perissodactyls, primates, and artiodactyls) and marine mammals (like cetaceans and sirenians). Plausible existence of corridor(s) for secular migration allowed for faunal exchanges between India and Eurasia close to ~56–57 Ma, particularly for the large-

sized mammals (> 35 kg) (e.g., perissodactyls such as cambaytheres and tapiromorphs) (Figs 3-4). The directions of biotic migrations between India and its surrounding continents between the ~ 66 to ~ 50 Ma time slice remains to be fully understood; however, the sweep stakes and/or island-hopping dispersal mechanisms were the most likely mode of migration for the small- and medium-sized mammals (Figs 8-9). Further, there is now a revived interest in the early Paleogene vertebrate palaeontology of India due to recent data on biostratigraphically constrained Paleocene and early-middle Eocene vertebrate records (such as fish, reptiles, and amphibians along with associated coprolite ichnofossils) from the western and northeastern regions of India.

An isolated rodent lower molar is reported from the Middle Siwalik subgroup exposed in the Mohand Rao Section (MR) and along the Saharanpur-Dehradun road. The occurrence of this mouse lineage, *Parapelomys*, is consistent with the Late Miocene age. The fossil represents a species of the advanced murine rodent genus *Parapelomys*, a species apparently more primitive and older than the type species of the genus *Parapelomys robertsi* (Fig 10).

The plant fossil record of Bhavnagar is poorly documented despite its importance in understanding the evolution of Asian monsoonal ecosystems through time. Three genera of the families Fabaceae and Combretaceae are described from the Gaj Formation of Saurashtra Basin, Gujarat. The sediments of this formation are exposed around Lakhanka-Mithi Viridi villages in the Bhavnagar District

of Gujarat and considered of early to middle Miocene in age. This is the first plant fossil record from the region of this age. The described fossil woods, i.e. *Hopeoxylon speciosum* (Navale) Awasthi, *Millettioxylon palaeopulchra* Lakhanpal *et al.*, and *Terminalia tomentosa* Wight and Arn. are found similar to the modern genera *Sindora* Miq., *Millettia* Wight & Arn (Fabaceae) and *Terminalia* L. (Combretaceae), respectively. The present distribution of modern comparable forms of the fossil taxa suggests existence of tropical to subtropical forests and warm and humid climatic conditions in the region during the Miocene in contrast to the sub-humid to dry climate seen today.

The dominance of angiosperms achieved around the late Cretaceous–early Palaeogene time can be observed through multiple well-preserved fossil flowers and fruits described from the early Palaeogene sediments of Bikaner and Barmer, Rajasthan, India (Fig. 11). Twelve pentamerous fossil flowers are reported and categorized into three morphotypes mainly based on their petal's shape and pattern. Fossil pollen *Rhoipites anacardioides* Ramanujam, extracted from the preserved androecium of one of the fossil flowers, has shown strong affinity with the modern pollen of the family Anacardiaceae. Apart from flowers, a pentamerous fossil fruit encompassing a single whorl of five carpels alternating with petals is found similar to the extinct genus *Chaneya* Wang and Manchester. These fossils provide a cinematic picture of the beautiful flowering and fruiting phases during the early Palaeogene, well known for the major diversification of angiosperms.

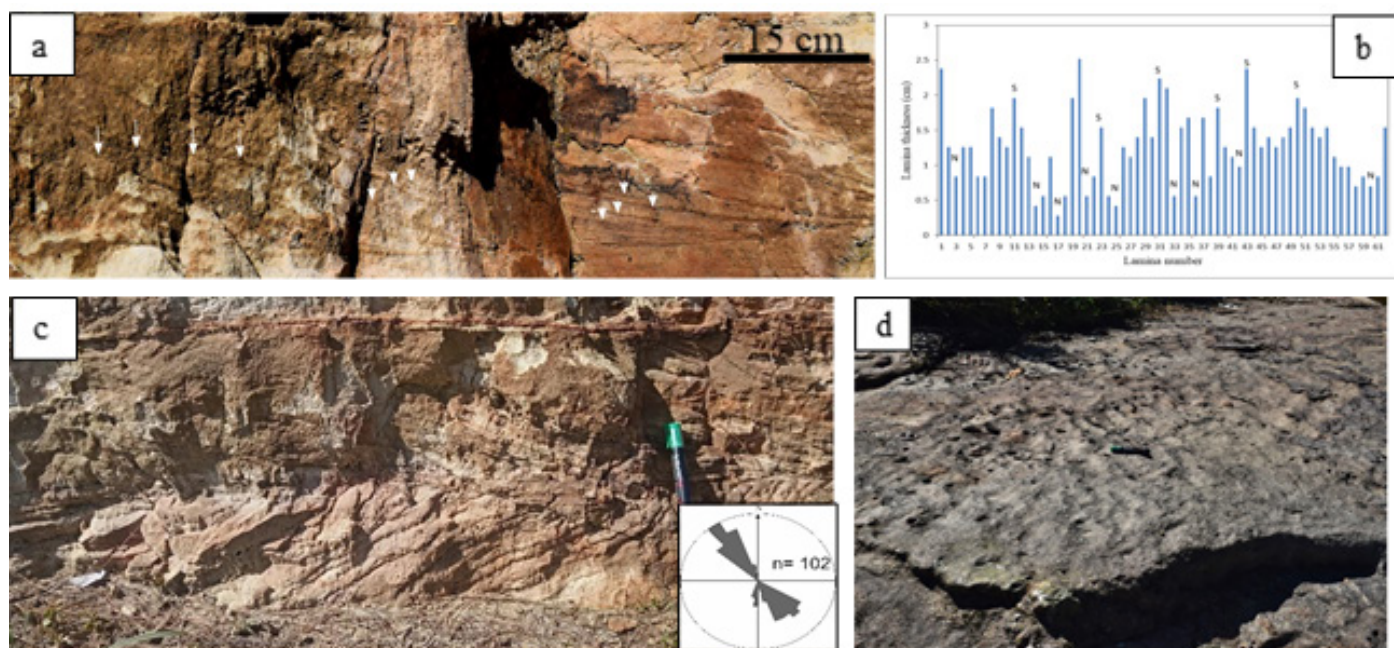


Fig. 13 - (a) Double mud drapes around the sandy foresets imply deposition took place within a subtidal setting; (b) Thickness variation of the sand laminae in a cyclic pattern; (c) Herringbone cross-stratification. Note, bidirectional and bipolar palaeocurrent pattern is shown in the inset; (d) Wave ripples on the bedding plane.

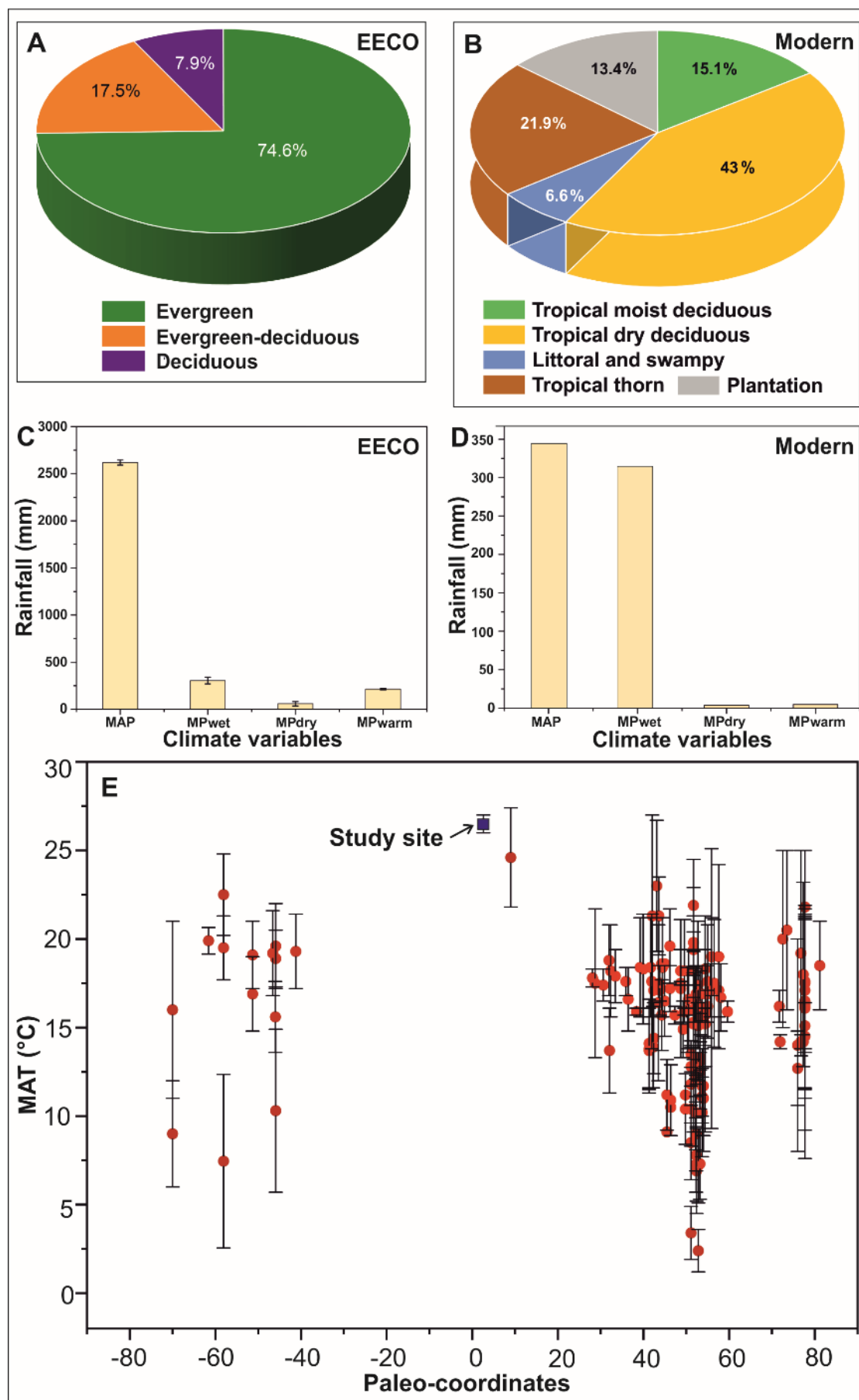


Fig. 14 - A-B. Pi diagram showing the percentage of taxa distributed in different forest types during the EECO (~52 Ma) and modern-day. C-D. Bar graph showing the reconstructed climate variables during the EECO and modern-day. E. Graph showing the reconstructed mean annual temperature (MAT) from the present study site and already known sites.



The biotic assemblage of the early Miocene (Burdigalian) Quilon Limestone has been investigated in detail from the Channa Kodi (Kerala Basin). The assemblage comprises abundant soritid foraminifer *Pseudotaberina malabarica* and various species of green alga *Halimeda* in a floatstone facies (Fig. 12). The recorded assemblage represents an excellent archive of Indo-Pacific seagrass community. Light and temperature are interpreted as the major ecological drivers of the seagrass palaeocommunity. These taxa show close affinity to the biotic communities from the carbonate successions in Sri Lanka, Java and northern Africa.

In another case study, the reworked palynofloral assemblage examined from the Subathu Formation outcrops in Himachal Pradesh and Haryana include 23 genera and 27 species of pteridophytic spores, gymnospermous pollen and dinoflagellate cysts. Most of the material in Shimla Hills is interpreted to have derived from the Permian and Late Jurassic-Early Cretaceous sediments from the Spiti localities, while that for the Morni Hills might have come from some isolated outcrops exposed near the Nahan area of Himachal Pradesh indicating longer transportation.

The sedimentological study in the Upper Mahadek Formation, south Shillong Plateau highlights the fluvial to marine transition during the Late Cretaceous. Sedimentary facies analysis shows that marine transgression took place from the south–southwest part of the plateau. However, the nature and extent of the marine depositional system vary spatially. A tide-dominated environment developed directly overlying the Precambrian basement in the northern part of the basin as depicted by herringbone cross-strata, double mud drapes between cross-strata, thickness variation of the sand lamina in a cyclic pattern, bidirectional and bipolar palaeocurrent pattern. Identification of reactivation surfaces as well as lateral change in stratification style with changing free stream velocity and increase in suspension load input rate corroborate the tide interpretation. On the other hand, a wave-dominated open shelf condition was developed during intense marine encroachments in southwestern part as depicted by the presence of hummocky cross-stratification, wave ripples, wave-winnowed lag deposits and occurrence of marine invertebrate fossils (Fig. 13).

The rainforests situated near the palaeo-equator at ~52 Ma exhibited greater resistance to greenhouse warming compared to vegetation at mid-latitudes. However, the mechanisms underlying this are unknown due to lack of reliable terrestrial climate data from equatorial regions. The study conducted using plant (spore-pollen) proxy approach, suggested that at ~52 Ma the climate near the palaeo-equator (~2.6° N) was warmer than other palaeolatitudes. Moreover, it also suggests that high levels of rainfall close to the palaeo-equator might have enhanced

the resilience of tropical rainforests by increasing the water use efficiency of plants (Fig. 14). By revealing the role of rainfall in mitigating heat stress, this research offers insights into safeguarding tropical ecosystems amid ongoing global warming. Understanding how rainforests coped in the past can help us protect them from global warming now.

PROJECT OUTCOME

In SCI (Science Citation Index) Journal

1. Agnihotri P, Singh H, Subramanian KA & Acharya S 2023. Scanning electron microscopy of *Sarcoptes kutchensis*, a new species of a Middle Eocene sarcoptid mite in amber from the Umarsar Lignite Mine of Kutch, western India. *Historical Biology*. <https://doi.org/10.1080/08912963.2023.2281579> (IF: 2.25).
2. Bhandari A, Flynn, LJ & Lokho K 2023. Discovery of *Parapelomys* (Murinae) from the Siwalik Group of Mohand, NW Himalaya: palaeobiogeography implications. *Journal of the Palaeontological Society of India*. 68(2): 147–153. <https://doi.org/10.1177/05529360231205119> (IF: 0.833).
3. Bhatia H, Srivastava G & Mehrotra RC 2023. *Duabanga* (Lythraceae) from the Oligocene of India and its climatic and phytogeographic significance. *Geobios* 78: 1–13. <https://doi.org/10.1016/j.geobios.2023.05.003> (IF: 1.6).
4. Chandra K, Verma P, Shukla A & Mehrotra RC 2023. Pentamerous fossil flowers and fruits from Rajasthan reveal the dominance of flowering plants in the early Palaeogene of India. *Current Science* 125 (3): 321–324. DOI.: <https://doi.org/10.18520/cs/v125/i3/321-324> (IF: 1.169).
5. Kapur VV 2024. Current developments in Paleogene vertebrate palaeontology in view of India's final drift phase and India-Eurasia docking: An appraisal. *Proceedings of the Indian National Science Academy*. <https://doi.org/10.1007/s43538-024-00272-3> (IF: 0.9).
6. Lokho K, Carrasco JF, Biswal S, Whiso K & Bhandari A 2023. First Report of Eocene Echinoids from the Sylhet Limestone, Mikir Hills of Assam, India: Palaeontological, Palaeogeography and palaeoenvironmental significance. *Journal of the Palaeontological Society of India* 68(2): 188–198. (Doi.org/10.1177/05529360231205313) (IF: 0.833).
7. Sarkar S, Singh YP & Verma P 2024. Palaeoecological and palaeobiogeographic implications of a seagrass-indicating for algal skeletal assemblage: Retracing

the Burdigalian Quilon Limestone (Kerala Basin, SW India). *Marine Micropaleontology* 187: 102330. <https://doi.org/10.1016/j.marmicro.2023.102330> (IF: 1.9).

8. Shukla A, Chandra K, Shukla S & Mehrotra RC 2023. Miocene Wood Assemblage from the Saurashtra Basin, Gujarat and its climatic significance. *Journal of the Geological Society of India*. 99(4): 509-514. (IF: 1.3).
9. Srivastava G, Bhatia H, Verma P, Singh YP, Utescher T & Mehrotra RC 2023. High rainfall afforded resilience to tropical rainforests during Early Eocene Climatic Optimum. *Palaeogeography, Palaeoclimatology, Palaeoecology* 628: 111762. <https://doi.org/10.1016/j.palaeo.2023.111762> (IF: 3.0).
10. Uddandam PR, Kapur VV, Parmar S, Bansal M, Manoj MC, Sharma A & Prasad V 2023. Danian-Ypresian dinocyst biostratigraphy, fish fauna and depositional environment of the Akli Formation, Barmer Basin, western India. *Historical Biology*. <https://doi.org/10.1080/08912963.2023.2214585>. (IF: 2.25).

Referred Non-SCI Journals

1. Sarkar S & Sarkar S 2023. Reworked Permian and Jurassic-Cretaceous palynofossils from the Subathu Formation (late Ypresian-middle Lutetian) of the Lesser Himalayas, India and their palaeogeographic significance. *Geophytology* 53: 181-188.
2. Uddandam PR, Agnihotri P, Agrawal S & Singh H 2023. Early Eocene biotic assemblage from the sedimentary deposits of the Tarkeshwar Lignite Mine, Gujarat and its palaeoenvironmental implications. *Journal of Palaeosciences* 72(2): 127-139.

Book chapter/Memoirs/ Bulletins

1. Bhatia H, Srivastava G, Mehrotra RC & Paudyal KN 2023. Floral diversity and climate change in the Siwalik Succession. In: Phartiyal B, Mohan R, Chakraborty S, Dutta V & Gupta AK (Editors) - Climate change and environmental impacts: Past, present and future perspective. Society of Earth Scientists Series. Springer, Cham. https://doi.org/10.1007/978-3-031-13119-6_1.
2. Singh YP, Verma P & Singh A 2023. Palynofloral diversity during Mid-Miocene warming in Kerala Basin, south-western India: Palaeoclimatic implications. In: Phartiyal B, Mohan R, Chakraborty S, Dutta V & Gupta AK (Editors) - Climate change and environmental impacts: Past, present and future perspective. Society of Earth Scientists Series. Springer, Cham. https://doi.org/10.1007/978-3-031-13119-6_4.

General Articles/Reports/Database Published

1. Bhandari A, Mohd Hussain, Ashokrao Ingle P & Kumar A 2023. National Workshop on Biodiversity & Conservation in the Himalayan Region. *Journal of Palaeosciences* 72(2): 179-181. (Doi.org/10. 54991/jop.2023.1866).
2. Choudhuri A, Mandal S, Bumby A & Pillai SSK 2023. Glacial sedimentation in Northern Gondwana: insights from the Talchir Formation, Manendragarh, India. *Geological Magazine* 160: 1228-1240 (IF: 2.656).
3. Kapur VV, Sagar R, Kamlesh K, Chaddha AS, Lourembam RS, Mishra A & Sharma A 2023. Palaeobiological and geochemical aspects of reptilian coprolites from a Maastrichtian Deccan volcano-sedimentary intertrappean deposit of central India. ESS Open archive. DOI: 10.22541/essoar.168167286.66007656/v1
4. Quamar FM, Srivastava G, Rai N & Ahlawat B 2024. Emerging insights on human histories and past environments in South Asia. *Journal of Geological Society of India* 100 (3): 455. <https://doi.org/10.17491/jgsi/2024/173854>.

Publications other than Project Work

1. Adhikari P, Bhatia H, Khatri DB, Srivastava G, Uhl D, Mehrotra RC & Paudyal KN 2023. Plant fossils from the middle Siwalik of eastern Nepal and their climatic and phytogeographic significance. *Palaeobiodiversity and Palaeoenvironments* 103: 57–69 (IF: 1.4).
2. Alam M, Tripti M, Gurumurthy GP, Arif M, Singh AD, Radhakrishna T, Pandey DK & Verma K 2023. Hydroclimatic conditions and sediment provenance in the northeastern Arabian Sea since the late Miocene: insights from geochemical and environmental magnetic records at IODP Site U1457 of the Laxmi Basin. *Geological Magazine* 160(4): 813-829. DOI: <https://doi.org/10.1017/S0016756822001273> (IF: 2.656).
3. Arora P, Trivedi PM, Bhatia H, Agnihotri P & Kapur VV 2023. A survey of the anticipated role of the Indian Museum of Earth (TIME) to Foster Public Awareness towards the preservation of palaeontological relics. *Geoheritage* 15: 109. <https://doi.org/10.1007/s12371-023-00877-y> (IF: 3.3).
4. Choudhuri A, El Albani A, Mandal S & Sarkar S 2023. Biotic vs abiotic origin of unusual features from Mesoproterozoic of Vindhyan Supergroup, India. *Annales de Paléontologie*, 109: 1-12 (IF: 1).
5. Gao Y, Song A, Deng W, Chen LL, Liu J, Li WC,

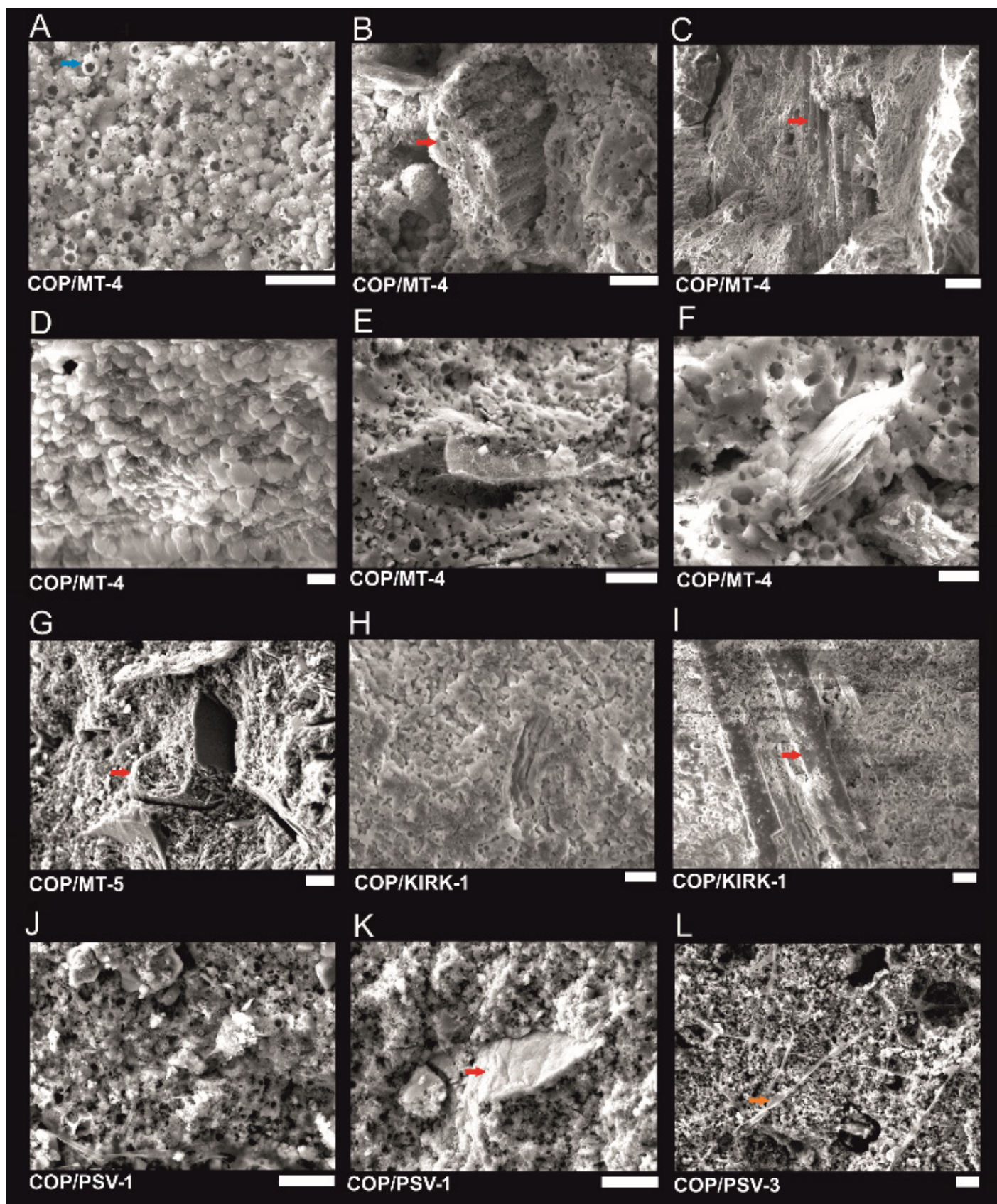


Fig. SP 3.3(a) - Scanning electron microphotographs of the early-middle Miocene (Aquitanian-Langhian) vertebrate coprolites from the Kachchh region (western India) depicting internal texture, structures, and biotic inclusions. A-F: Morphotype 'C', Specimen No. COP/MT-4; G: Morphotype 'B', Specimen No. COP/MT-5; H-I: Morphotype 'C', Specimen No. COP/KIRK-1. Note the presence of bone matter (red arrow); walled microspherulites - egg-like spherical bodies generally linked to bacteria (blue arrow) and fungal hyphae (orange arrow). Scale bar equals 10 μ m for A-B, E, G-I; 20 μ m for C; 7 μ m for D; 4 μ m for F.

- Srivastava G, Spicer RA, Zhou ZK & Su T 2023. The oldest fossil record of *Bauhinia* sp. (Fabaceae) from the Tibetan Plateau sheds light on its evolutionary and biogeographic implications. *Journal of Systematics Palaeontology* 21 (1): 2244495. <https://doi.org/10.1080/14772019.2023.2244495> (IF: 2.6).
6. Goswami S, Pradhan S, Aggarwal N, Mathews RP, Manoj MC, Pillai SSK & Pradhan SS 2023. Integrative study of Permian coal-bearing horizons: Biostratigraphy, palaeovegetation, and palaeoclimate in the South Karanpura Basin. *Environmental Geochemistry and Health* 45: 6985–7010 (IF: 4.2).
 7. Kapur VV & Chauhan G 2024. Miocene (~ 14 Ma) vertebrate-yielding site of Palasava, Kachchh, Gujarat State, western India: Geoheritage-Geotourism perspective and geosite potential. *Geoheritage*. 16(12). DOI: 10.1007/s12371-024-00915-3 (IF: 3.3).
 8. Sharifi J, Nasiri Y, Badpa M, Taghdisi Nikbakht S, Sarkar S & Hadi M 2023. Depositional environment and sequence stratigraphy of the Qom Formation (Miocene) from the Ghalibaf section, central Iran. *Boletín de la Sociedad Geológica Mexicana* 75, A061023. http://boletinsgm.igeolcu.unam.mx/bsgm/vols/epoca04/7503/A061023_Sharifi.pdf (IF: 0.85).

SPONSORED PROJECTS (SP) AND COLLABORATIVE PROJECTS (CP)

SP 3.1: Reconstruction of Paleobathymetric variations through time from middle to late Eocene and reconstruction of paleogeographic maps of Cambay Basin during middle to late Eocene (Sponsored by ONGC-RGL, Vadodara: SAP OUTLINE AGREEMENT NO. 9010034150); February 2022 to March 2024.

Investigator(s): Vandana Prasad (PI), Poonam Varma (Co-PI), Abha Singh (Co-PI), Prem Raj Uddandam (Co-PI), Shreya Mishra (Co-PI), Suman Sarkar (Co-PI)

The BSIP-ONGC RGL Vadodara project successfully completed in which total 1404 sediment samples and palaeontological slides were provided from 30 wells of Cambay Basin, Gujarat by ONGC-RGL, Vadodara for the study for foraminifera, calcareous nannofossil, dinoflagellate cysts and spore-pollen. Integrated biostratigraphy based on the integration of foraminifera and dinoflagellate cysts and nannofossil marker fossils data have been attempted for precise dating of the interval samples. The stage boundaries of middle Eocene have been demarcated in some wells. In addition, the palaeoenvironmental interpretations of each well have been done on the basis of relative changes in spore-pollen

palaeoecological assemblages. The palaeobathymetric and palaeogeographic reconstruction has been done based on the faunal and floral fossil data of middle Eocene and late Eocene. For the reconstruction of palaeoshoreline map floral evidence recorded from the studied wells were considered. Shoreline was plotted considering the presence of mangrove pollens which flourish in the brackish environment. In addition to mangrove pollen fossil based palaeobathymetric data is also used for plotting tentative palaeoshore lines. The final report has been prepared and submitted to the funding agency.

SP 3.2. Biostratigraphic analysis of the sub-surface samples of Exploratory/Development wells of Oil India Limited (Sponsored by Oil India Limited, Assam: started on 28 August 2023; July 2023 to July 2025).

Investigator(s): Abhijit Mazumder, Poonam Verma, Abha Singh, Prem Raj Uddandam, Shreya Mishra, Suman Sarkar

The purpose of the project is to carry out detailed biostratigraphic studies of the well-cutting/core samples recovered while the drilling/coring of Exploratory/Development wells in OIL's operational areas. The project will employ the study of foraminifers, calcareous nannofossils, dinoflagellate cysts (dinocysts), and spore-pollen to provide age and also palynofacies analysis to provide palaeoenvironments of the studied wells. CGM-G&R, Duliajan, Assam supplied 66 drill-cutting samples from well Safrai-1 for palynological studies and 19 conventional core samples from well West Barekuri-1 for micropalaeontological (foraminiferal) studies. The report preparation is in progress.

SP 3.3: Palaeodietary habit(s) in deep time, linkages to producer taxa, and palaeoenvironmental inferences utilizing Mesozoic-Cenozoic fossilized faecal matter (coprolites) from India (Project No. CRG/2019/002204, Sponsored by SERB, New Delhi; from January 2020 – June 2023).

Investigators: Vivesh Vir Kapur (PI), Kamlesh Kumar (Co-PI1), P. Morthekai (Co-PI 2), Ramanand Sagar (JRF)

The project investigation has filled the fossil gap on vertebrate coprolites from the early-middle Miocene of Kachchh region, western India. The investigations have made a first attempt to showcase biotic inclusions within the coprolites recovered from the Miocene (Aquitania and Burdigalian) Khari Nadi and Chassra formations of Kutch Basin (Gujarat, western India). Biotic inclusions including plant and bone matter reflected the omnivorous diet of the producer chelonians. Additional biotic inclusions include ostracods; foraminifers; marine calcareous algae; chrysophytes (resting spores or cysts of planktonic algae);

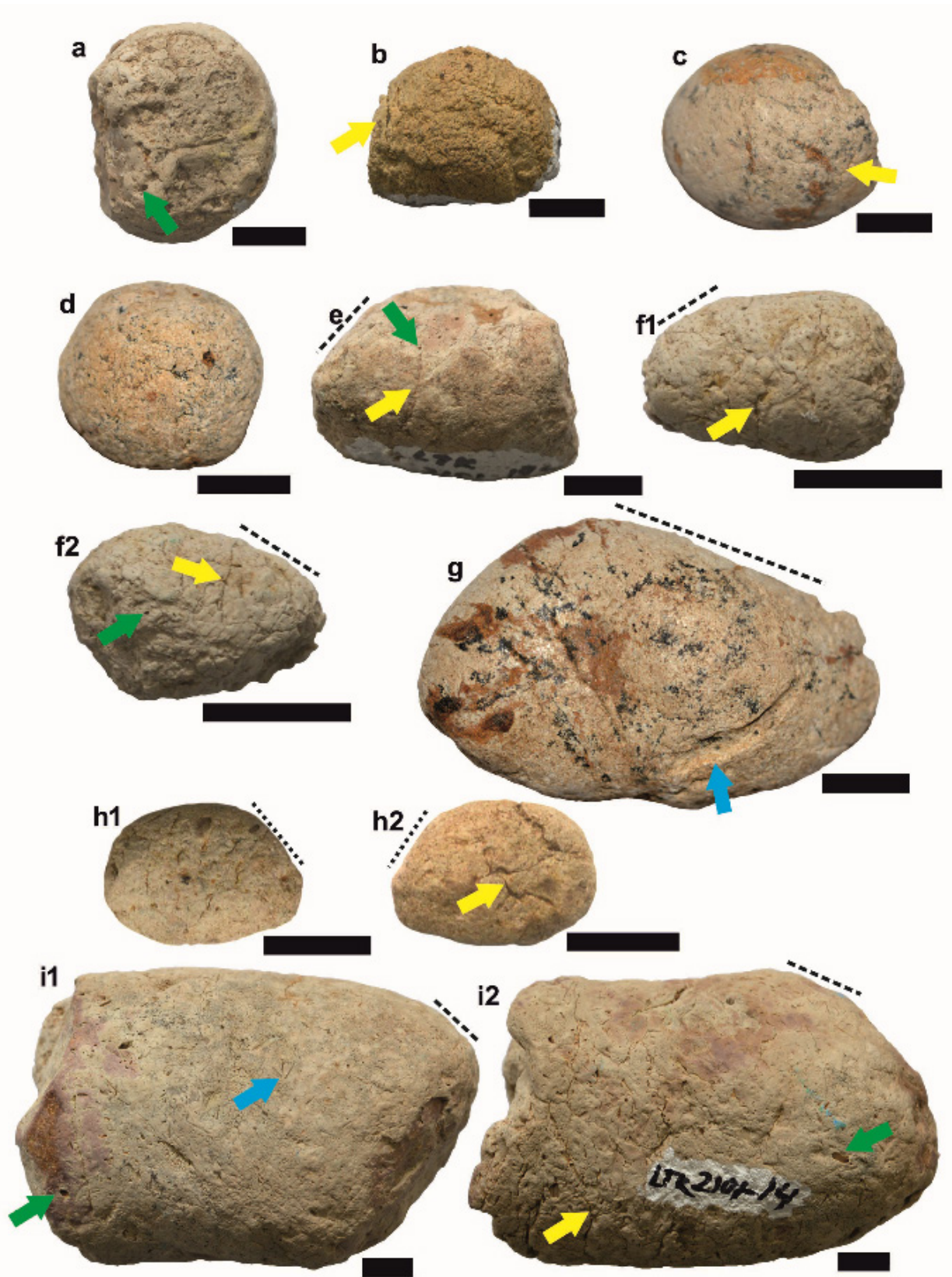


Fig SP 3.3(b) - Digital photographs of late Cretaceous (Maastrichtian) coprolite specimens recovered from an intertrappean deposit, central India. (a-d), Spherical Morphotype 'A', (a) specimen LTK/2101-154 (BSIP 42254); (b) specimen LTK/2101-234 (BSIP 42255); (c) specimen VVK/BNP/GEO2 (BSIP 42256); (d) specimen VVK/BNP/GEO1 (BSIP 42253). (e-i) Tear-drop shaped Morphotype 'B', (e) specimen LTK/2101-194 (BSIP 42258); (f1-f2) specimen LTK/2101-351 (BSIP 42260); (g) specimen VVK/BNP/GEO12 (BSIP 42257); (h1-h2) specimen LTK/2101-321 (BSIP 42261); (i1-i2) specimen LTK/2101-14 (BSIP 42259). Note: Green arrow marks burrow structures, yellow arrow marks desiccation cracks, light blue arrow points towards dentalites/bite traces, and dashed lines highlight the prominent inclination. Scale bar equals 1 cm for all.

sponge spicules; freshwater diatom and unidentified fungal remains. The presence of microspherulites/spherical cavities (egg-like mineral spheres – bacterial remains), pyrite inclusions and Sulphur (EDS analysis) suggested that the coprolites were deposited in a reducing environment and underwent partial decomposition post-deposition (Fig. SP3.3(a)). Overall, the biotic and abiotic inclusions, geochemical data, and associated vertebrate remains suggested that the coprolites were deposited in a dominantly coastal marine (intertidal) setting linked to a lacustrine/palustrine environment. The investigation also showcased that the longitudinal striations are not restricted to crocodilian coprolites as is often assumed. The project investigations have filled the fossil gap on vertebrate coprolites from the Paleocene (Thanetian) of India. The project investigations have allowed to link the coprolites recovered from the Maastrichtian intertrappean deposit in Madhya Pradesh to two reptilian groups, i.e. chelonians and crocodiles. Investigations have provided rare evidence of two different types of bite traces, herein linked to the garfish *Lepisosteus* and to an unknown animal practicing coprophagy (Fig. SP 3.3(b)).

SP 3.4: Appraisal of the Neogene vegetation shift and climate change in northern India, based on plant mega fossils (Project No. CRG/2019/002461, from January 29, 2020 – July 28, 2023).

Investigators: Gaurav Srivastava (PI), RC Mehrotra (Co-PI)

Understanding the evolutionary history of climate in northern India is still far from satisfactory. We use plant fossils collected from various horizons of the Neogene sediments from northern India. The reconstruction suggests that northern India enjoyed a warm and humid climate during the Neogene. Moreover, the quantitative climate data reveals that a distinct seasonality was present between the wettest and driest months. The reconstructed temperature data suggests that the middle Miocene was warmer than the lower and upper Miocene. Moreover, the vegetation data suggests the dominance of wet evergreen taxa during the early and middle Miocene, while deciduous ones increased significantly during the late Miocene.

SP 3.5: Indian monsoon seasonal dynamics across mid-Pleistocene transition (Project No. SRG/2022/002129, from 2022 to July 28, 2023).

Investigators: Prem Raj Uddandam (PI)

Summer monsoon intensity and sea level have experienced drastic changes during the past 10 Kyr that has a severe impact on mankind. Arabian Sea (AS) primary productivity records are crucial for understanding past

changes in the Indian monsoon dynamics. A multiproxy study of biotic proxies organic walled dinoflagellate cysts, calcareous walled dinoflagellate cysts, nannofossils and palynofacies analysis is carried out on a sedimentary core from the eastern Arabian Sea from oxygen minimum zone (240 m). The studied core covers the entire Holocene and shows temporal variations palaeoenvironments, sea level changes and primary productivity. Although the responses of the studied proxies vary, it is evident that prior to the 10 ka BP when sea level was low weak wind mixing and summer monsoon runoff resulted in relatively oligotrophic conditions and low productivity. Low TOC% during this period is also in support of low productivity compared to late Holocene. The productivity shows an increasing trend from 10 ka to 7 ka BP indicating intensified summer monsoon runoff and primary productivity. The late Holocene (since ~3.2 ka BP) shows high relative abundances of coccoliths, and TOC % revealing high productivity and increased organic matter flux to the sea flux due to the intensified wind mixing in the studied region.

OTHER ACADEMIC WORKS

Research papers presented

1. Arif Mohammad – Age and palaeoenvironmental implications of Deccan Intertrappean deposits from the Malwa subprovince: New insights from magnetostratigraphy, sedimentology and palynology (poster presentation). Deccan-next International Conference, held at Department of Geology, Savitribai Phule Pune University, Pune from 1-5 October 2023.
2. Arif Mohammad – Rock magnetism of sedimentary target rocks from the Ramgarh Crater: Implications for impact-related magnetic shock signatures (poster presentation). National Space Science Symposium 2024 (NSSS-2024), held at Goa University, Goa from 26 February - 1 March 2024.
3. Mishra Shreya – Palaeovegetational succession and palaeobiogeographic significance of the Maastrichtian flora from the Wardha Godavari Basin, India. Deccan-next International Conference, held at Department of Geology, Savitribai Phule Pune University, Pune from 1-5 October 2023.
4. Chetia Rimpay, Mathews RP & Singh Prakash K – Distinct plant-derived terpenoid suite from two important sedimentary basins of northwestern India. International Conference on 'Petroleum Exploration: Scopes, Prospects & Strategies with a Special Anecdote on North East India'. Mizoram University. 30-31 May 2023.
5. Kapur VV – Glimpses of the late Cretaceous



- (Maastrichtian) to Cenozoic (Miocene) coprolites from central and western India: Insights into the palaeodietary habit(s) of producer fauna and palaeoecological interactions. 2nd Council Meeting of the Asian Palaeontological Association (APA) and the Asian Palaeontological Young Scholars Forum, Nanjing, China, 25th to 27th November 2023. Session: S30.
6. Srivastava Gaurav – Floristic diversity and climate during the Last Glacial Maximum (LGM) evidence from Himalaya. International Conference during June 7–10, 2023 organized on the topic Emerging insights on human histories and past environments in South Asia.
 7. Bhatia Harshita – Late Oligocene modernisation of the evergreen forests and climate in South Asia, in International Virtual NECLIME Conference during December 1–4, 2023 organized on the topic “Evidence and drivers for origin and appearance of modern plants and vegetation types”.
 8. Srivastava Gaurav – High rainfall provided resilience to tropical evergreen forests during the Early Eocene Climatic Optimum, in International Virtual NECLIME Conference during December 1–4, 2023 organized on the topic “Evidence and drivers for origin and appearance of modern plants and vegetation types”.
 9. Bhandari A – Palaeontological records of fauna from NW Himalaya, India: Palaeobiodiversity & Biodiversity implications in National Workshop on Biodiversity & Conservation in the Himalayan Region at University of Ladakh, Leh Campus during 25th- 27th September, 2023, p. 25.
 10. Bhandari A & Tiwari BN – Miocene terrestrial biota from Dharmasala and Siwalik Group, NW Himalaya: Biostratigraphy & Palaeobiogeography implications in National Workshop on Geodynamics in Himalaya & Disaster Management at Central University of Himachal Pradesh (CUHP), Dharamshala Campus during 06th- 08th October, 2023, p. 119.
 11. Lokho K, Carrasco JF, Biswal S, Whiso K & Bhandari A – First report of Eocene Echinoids from the Sylhet Limestone, Mikir Hills of Assam, India in National Workshop on Geodynamics in Himalaya & Disaster Management at Central University of Himachal Pradesh (CUHP), Dharamshala Campus during 06th- 08th October, 2023, p. 40.
 12. Bhandari A – Palaeontological significance of Miocene fauna from NW Himalaya & Kutch in the International Conference on Climate Change and Geoscience at Department of Geology, Bangalore during 5th to 6th February, 2024, p.16.
 13. Choudhuri A - Evolution of a confined gravelly river to a braided-meandering river in the lake Cretaceous Khasi Group, Southern Shilong Plateau, NE India. 39th Convention of the Indian Association of Sedimentologists (IAS) & International Conference on “Voyage of Sedimentology from the Mountains to the Oceans: An Innovative Trajectory” from 6th-8th December 2023, p. 64.
 14. Nag D, Sangode SJ, Prasad V, Uddandam P, Choudhuri A & Mandal S – Mineralogical and rock magnetic signals of Deccan volcanism from the Cretaceous-Palaeogene section in Meghalaya, India. Deccan-next Conference from 1st-5th October, 2023, p.68.
 15. Choudhuri A - The advent of motile life in the Proterozoic: Scepticism and reality. National Conference on “Vindhyan Supergroup: Recent advances, challenges and opportunities”organised by GSI, Lucknow on 19th October, 2023, published in GSI Special Publication no. 128, p. 39.
 16. Jambhule D & Choudhuri A - Cyclicity and stromatolite morphological variations: Insights from the Bhandar Formation, Vindhyan Basin, India. National Conference on “Vindhyan Supergroup: Recent advances, challenges and opportunities” organised by GSI, Lucknow on 19th October, 2023, published in GSI Special Publication no. 128, p. 38.
 17. Choudhuri A, Jambhule D, Sinha S & Srimani S - Morphological variability of stromatolites and their cyclicity as an indicator of biogenicity- example from a Proterozoic carbonate platform of Vindhyan Supergroup, India. EGU General Assembly 2023 from 23rd - 28th April 2023.
- Deputation to Conferences/Seminars/Workshops (both online and offline)**
- Poonam Verma**
- Participated as an Expert Member in Nation Conference and Field Workshop on “Kachchh palaeo-rift Basin: an Ideal tectonic and sedimentary package for Indian geoheritage” organised by KSKV Kachchh University, Bhuj and the Society of Earth Scientists, Lucknow UP, during February 11-14, 2023.
 - Presented the expertise of BSIP in the field of petroleum exploration in the brain storming meeting organized at OIL, Duliajan, Assam, during May 26-27, 2023.
 - Participated NECLIME online Workshop on “Evidence and drivers for origin and appearance of modern plants and vegetation types” during December 1-4, 2023.
- Runcie Paul Mathew**
- ‘Indian coal/lignite-bearing sequences: Palaeoflora,

PH.D. PROGRAMMES

	Kajal Chandra (2019). Evolution and diversification of the early Palaeogene forest during the palaeoequatorial position of Rajasthan, under the supervision of Anumeha Shukla (BSIP) , registered with University of Lucknow, Lucknow. Status: Awarded .
	Priya Agnihotri (2019). Eocene Arthropods in amber from the Kutch and Cambay lignites, Gujarat, India: their bearing on palaeoenvironments, under the supervision of Hukam Singh (BSIP) and K.A. Subramanian (Zoological Survey of India, Chennai), registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: Awarded [October 2023].
	Yogesh Pal Singh (2016). Biostratigraphy and palaeoclimate reconstruction of Cenozoic successions of Kerala Basin, under the supervision of Poonam Verma (BSIP) and Rameshwar Bali (University of Lucknow, Lucknow), registered with Lucknow University, Lucknow. Status: Awarded October 2023
	Harshita Bhatia (2020). Advent of monsoonal climate and evolution of evergreen forests in South Asia: Evidence from the Oligocene flora of northeast India, under the supervision of Gaurav Srivastava (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: Submitted.
	Rimpy Chetia (2018). Organic geochemical and petrographic characterization of lignites from Barsingsar and Jalipa Mines of western Rajasthan, under the supervision of Runcie Paul Mathews (BSIP) and P.K. Singh, (Banaras Hindu University, Varanasi), registered with Banaras Hindu University, Varanasi. Status: In-progress.
	Sarvendra Pratap Singh (2019). Integrative palynological, magnetostratigraphic, and sedimentological studies of selected Deccan volcano-sedimentary sections of peninsular India: Implications for age, palaeoclimate, palaeobiogeography and evolutionary history of infra- & intertrappean biotas, under the supervision of Mohammad Arif (BSIP) and A.S. Naik (Banaras Hindu University, Varanasi), registered with Banaras Hindu University, Varanasi. Status: Submitted on 17/08/2023.
	Sadanand Pathak (2021). Neogene climate evolution vis-à-vis floristic changes in northern India, under the supervision of Gaurav Srivastava (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Samiksha Shukla (2021). Evolution, diversification, and dispersal history of the pantropical family Phyllanthaceae: Based on the recovered early Paleogene flora from north-western India, under the supervision of Anumeha Shukla (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Ramanand Sagar (2022). Palaeobiological and geochemical aspects of Mesozoic and Cenozoic vertebrate coprolites from central and western India, under the supervision of Vivesh Vir Kapur and Kamlesh Kumar (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Tapas Roy (2023). Facies tracts and sequence building of the Jhuran Formation, Kutch, India, under supervision of Adrita Choudhuri (BSIP) Anudeb Mandal (Presidency University) and registered with Presidency University, Kolkata. Status: In- progress.
	Satendra Kumar Gupta (2023). Geochemistry and Petrology of low-rank coal bearing sequences of Barmer Basin, western India: Implications to palaeoenvironment and hydrocarbon source potential, under the supervision of R.P. Mathews and Arvind K Singh (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Pawan Kumar Singh (2021). Study of plant mega fossils from the Siwalik Darjeeling District, West Bengal, India, under the supervision of Hukam Singh (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.

environments & new insights. International Conference on 'Petroleum Exploration: Scopes, Prospects & Strategies with a Special Anecdote on North East India'. Mizoram University, Mizoram, 30th to 31th May 2023.

Vivesh Vir Kapur

- Glimpses of the late Cretaceous (Maastrichtian) to Cenozoic (Miocene) coprolites from central and



western India: Insights into the palaeodietary habit(s) of producer fauna and palaeoecological interactions. 2nd Council Meeting of the Asian Palaeontological Association (APA) and the Asian Palaeontological Young Scholars Forum, Nanjing, China, 25th to 27th November 2023. Session: S30.

VP Mishra and Vivesh Vir Kapur

- Active role in Geoheritage Conservation and Geotourism in India (Palaeontological Society of India and Birbal Sahni Institute of Palaeosciences). 2nd Council Meeting of the Asian Palaeontological Association (APA) and the Asian Palaeontological Young Scholars Forum, Nanjing, China, 25th to 27th November 2023. Session: S30.

Training/Study Visits

Runcie Paul Mathews

- One week one lab. CIMFR, Dhanbad & Ranchi Campus, 22-26 August, 2023

CONSULTANCY/TECHNICAL SUPPORT RENDERED

Poonam Verma

- Cenozoic palynology Lab., Biostratigraphy, palynological studies and palynofacies analysis of OIL samples, Dr. Alok K. Singh, Professor (Geology), Rajiv Gandhi Institute of Petroleum Technology (RGIT), Jais, Amethi, Rs. 4,95,600/-

Runcie Paul Mathews

- Advanced Coal Petro-Geochemical Lab, FTIR analysis, Mr. Narendra Nath, Lucknow University, Rs. 1475/-
- Advanced Coal Petro-Geochemical Lab, Coal Maceral analysis, Ms. Madhurima Mazumdar, ISM Dhanbad, Rs. 4720/-
- Advanced Coal Petro-Geochemical Lab, GCMS analysis, Mr. Ramanand Yadav, Lucknow University, Rs. 5310/-
- Advanced Coal Petro-Geochemical Lab, GCMS analysis, Ms. Shivanjali Sharma, RGIT, Rs. 14160/-

Vivesh Vir Kapur

- As 'Member' of CPGG-BSIP visited together with Director (BSIP) and Convener (CPGG-BSIP) the Dhar Region, Madhya Pradesh to explore various Geoheritage sites and have meetings with Madhya Pradesh Ecotourism Development Board (MPETDB) officials from 6th to 9th December 2023 to further the work on the Geoheritage Conservation in the area.

- 'External Examiner' for B.Sc. (SEM-III) Geology Practical Examination, Lucknow University, Lucknow, Uttar Pradesh in April 2023.

Gaurav Srivastava

- Organized School/College Students' visit to Birbal Sahni Institute of Palaeosciences on July 19, 2023 as part of the SERB Scientific Social Responsibility (SERB SSR) activity.

ACCOLADES RECEIVED

Priya Agnihori & Hukam Singh

- "S.K. Singh Memorial Gold Medal" on 11th October, 2023, by the Palaeontological Society of India, Lucknow for the best scientific contribution among the papers published in the Journal Palaeontological Society of India, volume 67 (2): 357-362.

Ansuya Bhandari

- Chaired the Technical Session in the International Conference on Climate Change and Geoscience at Department of Geology, Bangalore on February 6, 2024.

Adrita Choudhuri

- Invited as a Distinguished Speaker in the 39th Convention of Indian Association of Sedimentologists (IAS) in Annamalai University during December 6-8, 2023.

Runcie Paul Mathews

- Invited as a Key-note Speaker in the International Conference on 'Petroleum Exploration: Scopes, Prospects & Strategies with a Special Anecdote on North East India'. Mizoram University, Mizoram, May 30-31, 2023.

REPRESENTATION IN COMMITTEES/BOARD

Hukam Singh

- Member of Executive Council: The Palaeobotanical Society, India

Vivesh Vir Kapur

- Member of Executive Council: The Palaeobotanical Society, India

Adrita Choudhuri

- Member of the International Commission on Stratigraphy (ICS) subcommission of Precambrian since 2023.

Project 4: Ocean and Polar paleoclimatic reconstruction during Neogene and Quaternary

COORDINATOR: PAWAN GOVIL (SCIENTIST E)

CO-COORDINATOR: VARTIKA SINGH (SCIENTIST E)

OBJECTIVES

- *Paleoceanographic variations from the western Indian Ocean during the mid-late Miocene: micropalaeontological and geochemical approach.*
- *Climate variability of the Southern Ocean over the Mid-Pleistocene Transition.*
- *Paleoceanography reconstruction from the western Indian Ocean during late Quaternary.*
- *Late Quaternary palaeoclimate reconstruction from the high latitude (polar: Arctic and Antarctica) using multiproxy data.*

PREAMBLE

Miocene: As the Earth warms, geological data and computer simulations of warm temperatures before the Quaternary Period are needed to predict future climate change. Global geological archives suggest warmer and more humid Miocene climates. Comparing proxy-based sea surface temperature reconstructions and palaeovegetation data with Late Miocene climate-vegetation model simulations show a 17-19°C global average. The Eocene's warm greenhouse environment became cooler, drier and less stable in the Miocene. After the middle Miocene climatic optimum (about 16 Ma), the East Antarctic ice sheets extended, rapidly cooling mid-latitudes to high latitudes and boosting zonality and surface ocean circulation by increasing deep-water production.

The late Paleogene and the late to mid-Neogene tectonic and terrestrial events can be correlated with climatic and marine cycles through the analysis of sediment layers. The middle to late Miocene Antarctic ice sheet extension and deep-water circulation alterations exacerbated latitude-specific temperature discrepancies. These alterations also altered low-latitude Southern Hemisphere processes.

Quaternary: The Southern Ocean (SO) serves as the primary connection between major ocean basins and plays a crucial role in shaping global climate patterns. The impact of Antarctica and the SO on Pleistocene climate is uncertain due to a lack of reliably dated palaeoenvironmental material close to Antarctica. Sedimentary records provide evidence of the movement of water in the deep ocean, the amount of sea ice, and the growth and shrinking of ice sheets. The Mid-Pleistocene Transition (MPT) refers to the shift in the frequency of Pleistocene glacial cycles from 41 to 100 thousand years. However, the exact nature of this transition remains disputed in the field of palaeoclimatology. This study examined the impact of the Indian Sub-Antarctic Southern Ocean on global climate change. Moreover, the western Indian Ocean is impacted by an intricate network of boundary currents, primarily the Mozambique and Agulhas Current. We analyze micropaleontology, sortable silt, and isotopic and elemental concentrations of planktic foraminifera to reconstruct changes in the surface, thermocline, and bottom hydrography over the late Quaternary Period.

Antarctica: Lake sediment cores from East Antarctica show the time limitation of the Holocene due to the availability of short sediment cores. Therefore, it is proposed to study



1st Row (L to R): Divya Verma, Brijesh Kumar, Amit K. Ghosh, Vartika Singh, Adhra Renny, Masud Kawsar; **2nd Row (L to R):** Hidayatullah Manoj M.C., Sunil K. Shukla, Pawan Govil, Abhijit Mazumder



long sediment cores to reconstruct climate-driven changes from the lakes and marine sediments over a longer time scale in the eastern Antarctic peripheral region during the Quaternary using sedimentological, geochemical, micropaleontological, Ancient DNA and biomarkers.

Arctic: Previous studies in the Arctic of Svalbard involve glacial geology, stratigraphy, sedimentology and environmental aspects of the late Quaternary paleoclimate. An attempt has thus been made to assess the late Quaternary paleoclimate of the Arctic using proxies such as dinoflagellates, thecamoebians, diatoms and organic matter study. The geomorphology and sediments of the post-glacial marine terraces contain valuable information about relative sea-level change and sea-ice extent.

PERSONNEL INVOLVED

Team Members: Abhijit Mazumder (Scientist D), Sunil Kumar Shukla (Scientist D), Manoj MC (Scientist D)

Associate Members: Anupam Sharma (Scientist G), Niraj Rai (Scientist D), Shailesh Agrawal (Scientist D), Santosh

K. Pandey (Scientist D), Arif K. Ansari (Scientist D), Gurumurthy (Scientist C)

Research Scholars: Hidayatullah, Brijesh Kumar, Divya Verma, Masud Kawsar, Sneha Mary Mathew

Emeritus Scientist (CSIR): Amit K. Ghosh

SIGNIFICANT FINDINGS

Paleoceanographic variations from the western Indian Ocean during the mid-late Miocene: a micropalaeontological and geochemical approach

The IODP Kochi Core Centre repository in Japan provided Miocene sediment samples from DSDP Site 237, a South Equatorial Current (SEC) hotspot (Fig.1). A total of 272 samples (5 to 25.8 million years) were collected, processed and evaluated for sedimentological characteristics and sortable silt (mean sortable silt -; volume percent of sortable silt – SS (vol%)) parameters to understand deep-water changes. This investigation used BSIP's Laser Particle Size Analyser. The goal is to ocean water masses

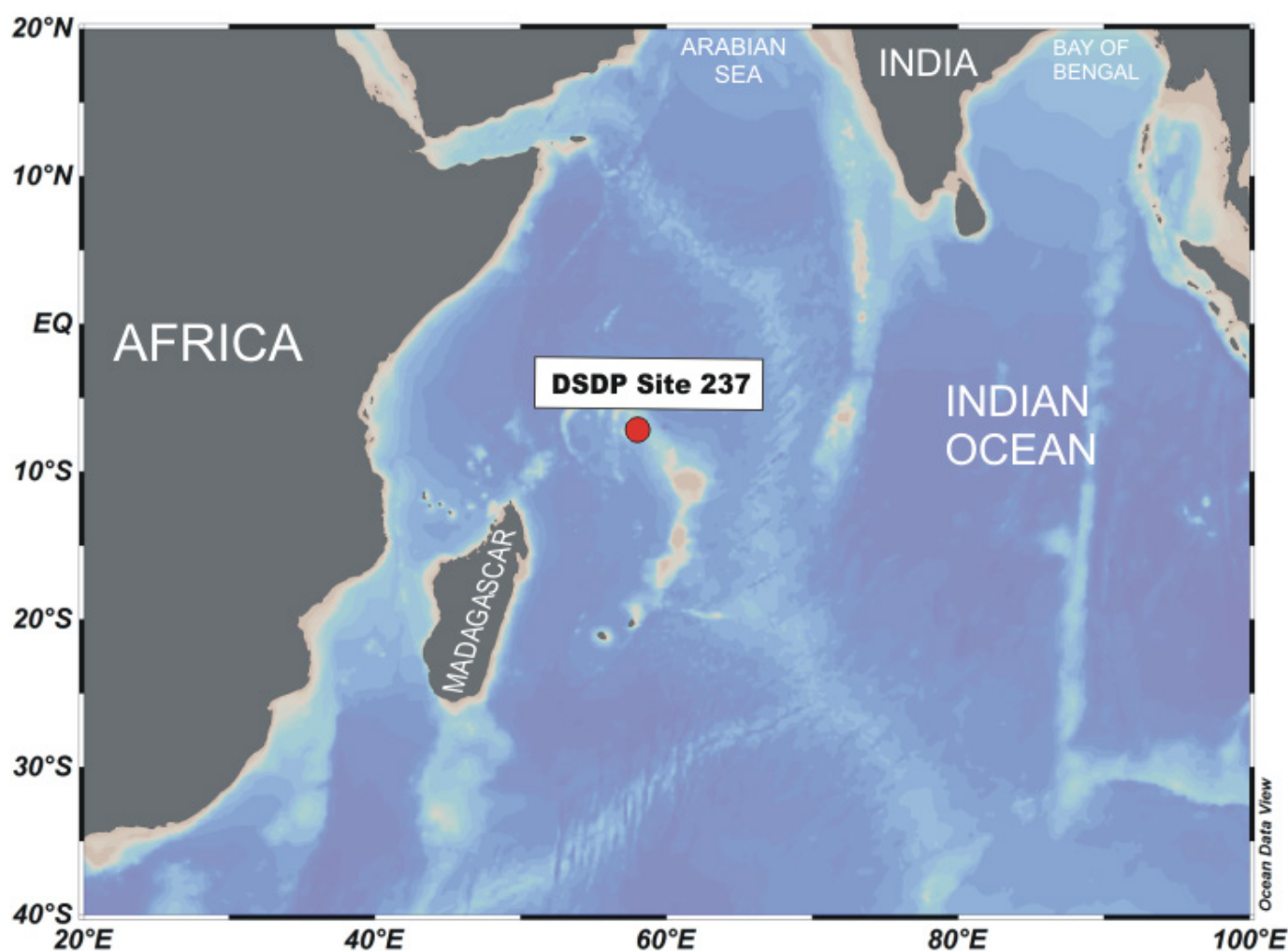


Fig. 1 - The location map of the DSDP site Leg 24 Site 237.

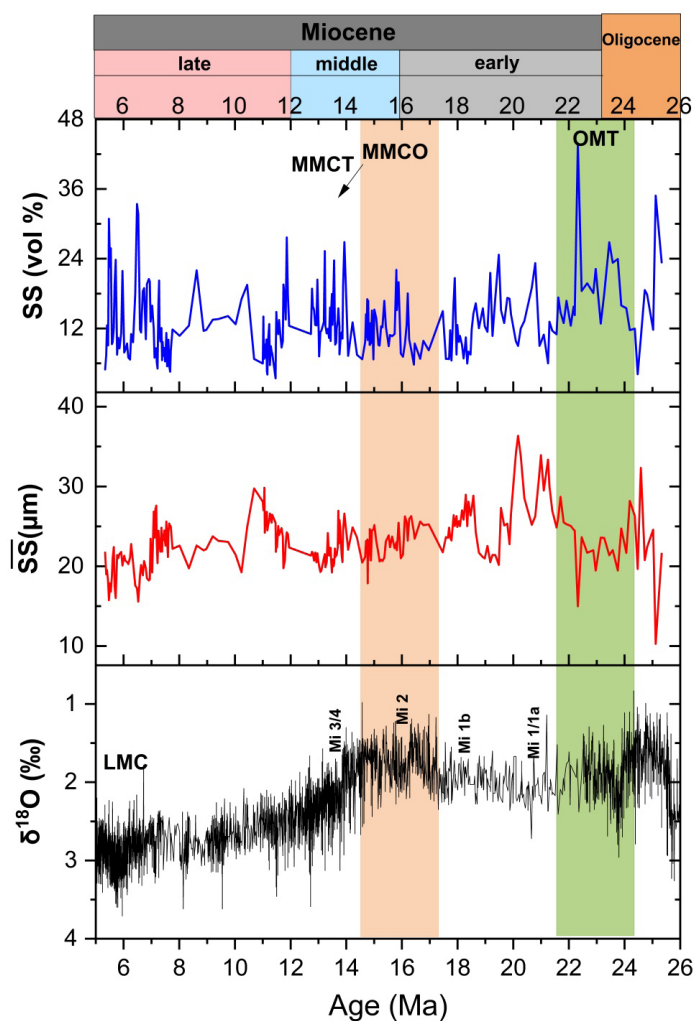


Fig. 2 - Comparison of SS and SS (vol%) record of the DSDP site Leg 24 Site 237 with global benthic foraminiferal oxygen isotope data (Zachos et al., 2008) during the Miocene Period.

and the relationship between productivity, monsoonal intensity, and deep-water circulation. The study examined deep-water intensities of Southern Component Water (SCW) and North Atlantic (NCW) Water masses. Bottom water currents increased during Mi 1/a, Mi 1b, Mi 2, and Mi 3/4 as the Miocene cooled (Fig. 2). The SS record fluctuated during the Miocene, demonstrating that SCW caused deep-water conditions to alter. End Member Model Analysis (EMMA) was also performed on bulk sediment texture data to identify sediment sources in the research area.

Climate variability of the Southern Ocean over the Mid-Pleistocene Transition (Core team member)

The MD218 CROTALE-C Cruise collected a sediment core (MD19-3576) from the Indian sector of the Southern Ocean (ISO) (Fig. 3), which was used for the micropalaeontological and sedimentological studies. The blue reflectance data of the MD19-3576 was calibrated using the benthic stable oxygen isotope stack (LR04) to determine its chronology. A total of 210 sediment samples (up to 1200 cm) were analyzed for the ice-rafted debris (IRD) analysis. Our research shows that biogenic particles exceeded the IRD (> 250 μm), especially during glacial and interglacial periods (Terminations V-IV, III-II) (Fig. 4). Lower biogenic fragments and higher IRD (15–35%) occur during glaciation. High blue reflectance and more biogenic fragments indicate that warmth lowered ice covering during interglacial and major terminations, enhancing productivity in ISO. Garnet and quartz-containing lithic grains in the IRD flow, notably during Terminations V and IV, indicating Antarctic ice mass loss

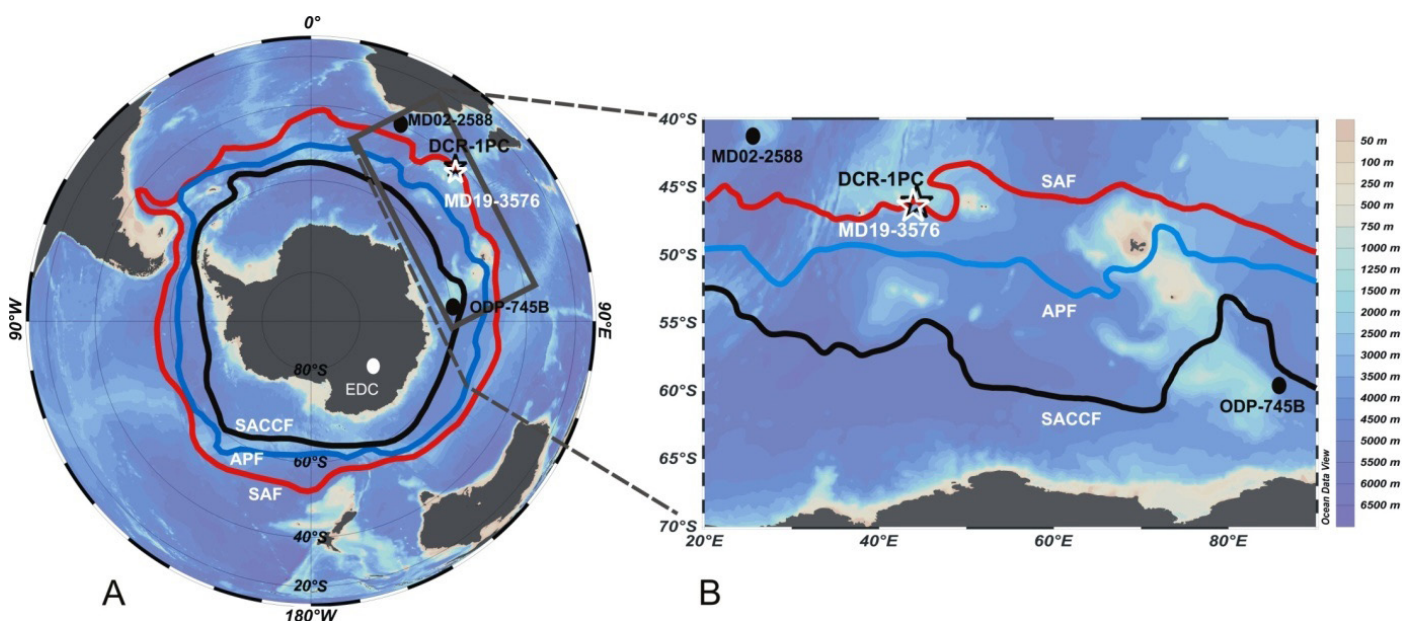


Fig. 3 - The location of the studied cores DCR-1PC (black star) and MD19-3576 (white star) for the palaeoceanographic records in the Sub-Antarctic zone of the Indian sector of the Southern Ocean(A). A close-up map is also shown (B). Locations of published cores are also shown (black circles). Positions of the Sub-Antarctic Front (SAF - red line), Antarctic Polar Front (APF - blue line), and southern Antarctic Circumpolar Current Front (SACCF – black line) are shown after Park *et al.* (2019).

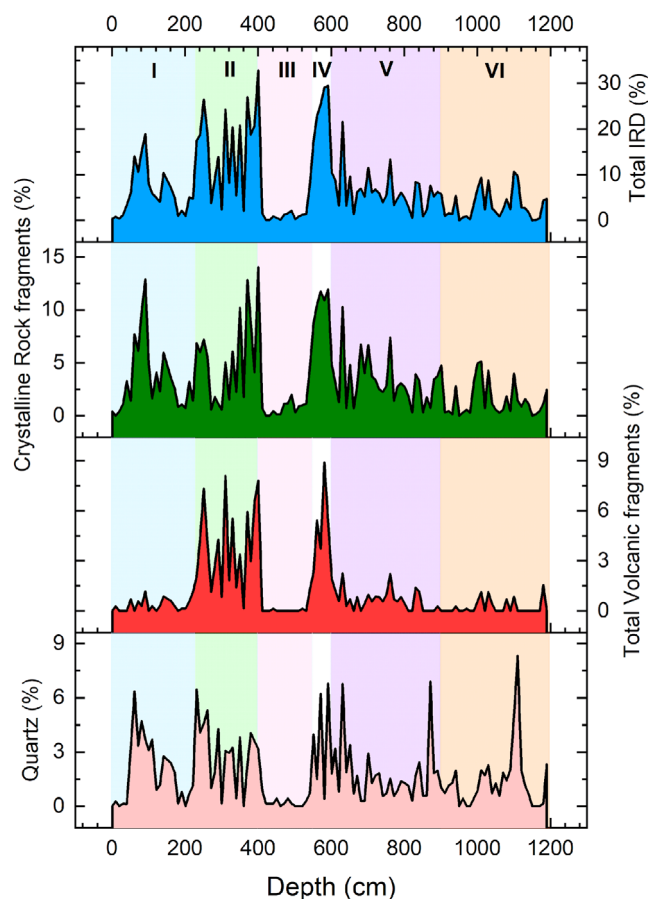


Fig. 4 - Down core variation of the total IRD-, Lithic-, Volcanic and Quartz -grains of the MD19-3576.

may contribute to the IRD flux. This indicates the northern limit of Pleistocene Antarctic iceberg variation in the ISO.

Paleoceanographic reconstruction of the western Indian Ocean during the late Quaternary

Our study focuses on proxy-based studies to better understand glacial-interglacial heat balance changes from thermocline to mixed layer level in the western Indian Ocean. The west of Indian Ocean marine sediment cores improve our understanding of late Quaternary Ocean circulation and monsoon variability (Fig. 5). VM29-045 core records the past changes (~412 kyr) in western equatorial Indian Ocean dynamics, revealing the impact of shifting of the ITCZ and IOD on regional and global climate. Between 363.1-335 ka and 320.3-248.5 ka, the weak surface, subsurface gradient, and thick mixed layer/deeper thermocline were observed. The glacial-interglacial cycle also saw abrupt mixed layer and thermocline changes. Sediment core 47-PC (encompasses ~196.6 ky BP) from the western tropical Indian Ocean near the Mozambique Channel (MC) was used to study the planktonic foraminiferal assemblages. An increase in the relative abundance of *G. ruber*, which prefers oligotrophic to eutrophic, warm conditions, during interglacial periods (MIS5, and 1) and a decrease in *T. trilobus* suggests a strong austral summer monsoon and reduced transport of Indonesian Through flow (ITF) surface water fed

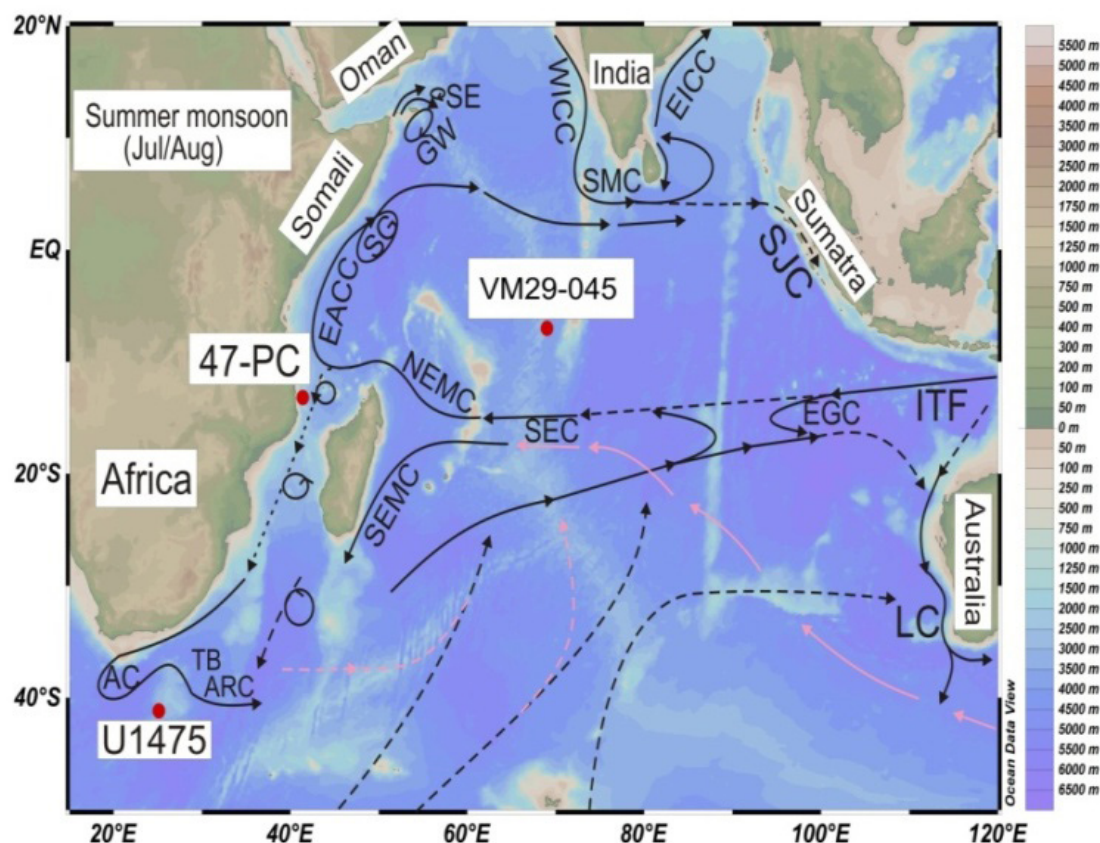


Fig. 5 - Location map of the marine sediment cores- VM29-045, 47-PC, and U1475 from the western Indian Ocean.

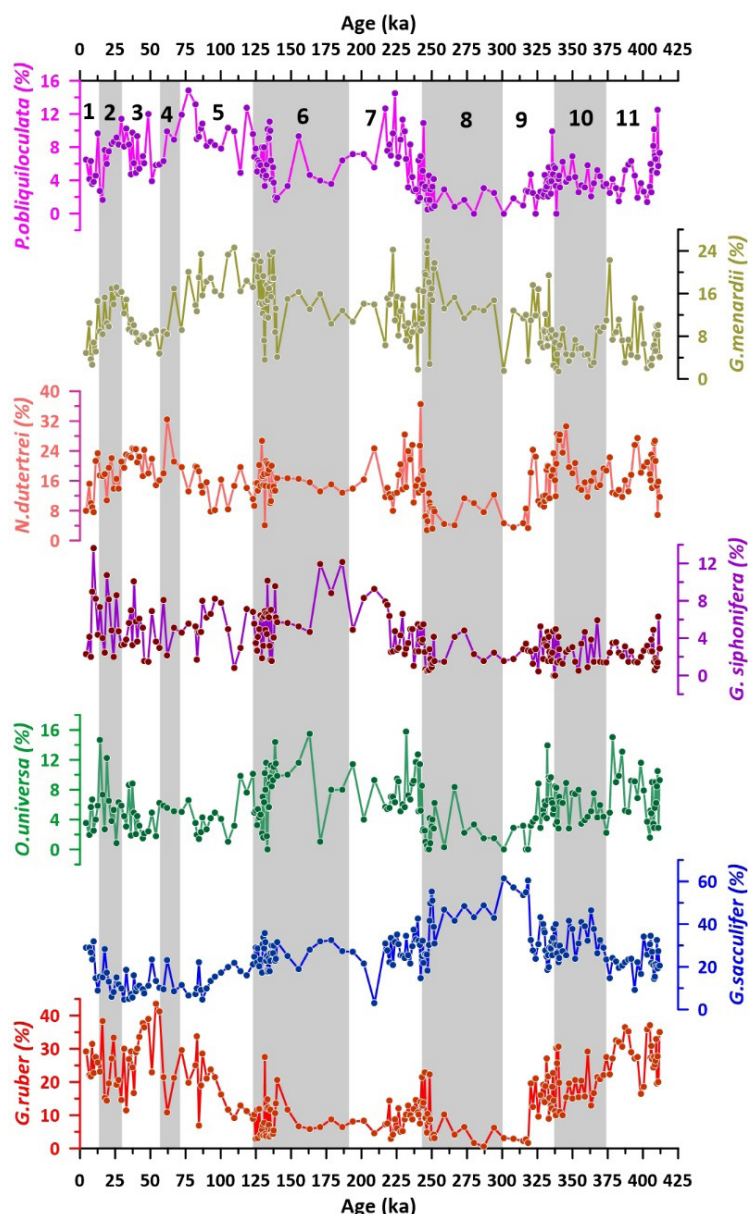


Fig. 6 - The mixed layer (surface) and thermocline planktonic foraminifera species abundance plots of VM29-045 core during the past ~412 ka.

westward flowing South Equatorial Current (Fig. 6). The third sediment core (U1475) shows an increased mixed layer species rise steadily during glacial periods (MIS 2, 4, 6, and 8), except in central MIS 7 (Fig. 7). This anomaly shows glacial periods feed the mixed layer with nutrients and boost productivity. The subtropical front migrating toward the equator may have brought nutrient-rich water to the core site (Fig. 8).

Late Quaternary paleoclimate reconstruction from the high latitude (polar: Arctic and Antarctica) using multiproxy data

Arctic:

Environmental and climatic changes are transforming high Arctic ecosystems. Studying biota can help to

explain how these changes affect the ecosystem under various ecological pressures. This has been evidenced in the microbiotic assemblage where there is a considerable rise in the population of opportunistic species. Modern analogs from various depositional settings have been examined. The study of organic-walled microzooplankton remnants comprised of chitin would guide further research on the biota of fresh-water ecosystems facing extreme warming at High Arctic locales (Fig. 9). Similar methods could be used to study past climate changes and biotic responses. The samples have been taken from Ny-Alesund, Svalbard, Arctic region. The dinoflagellate cyst record provides important ocean current dynamics data from the last interglacial in a climate-sensitive location. *Operculodinium centrocarpum* sensu Wall and Dale, *Nematosphaeropsis labyrinthus*, *Bitectatodinium tepikiense*, *Spiniferites elongatus* and *Spiniferites mirabilis*

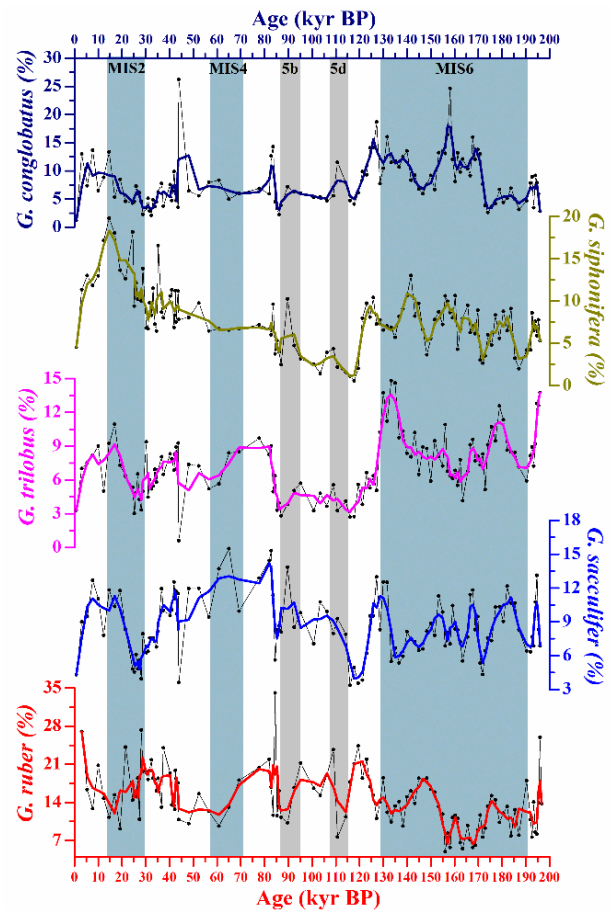
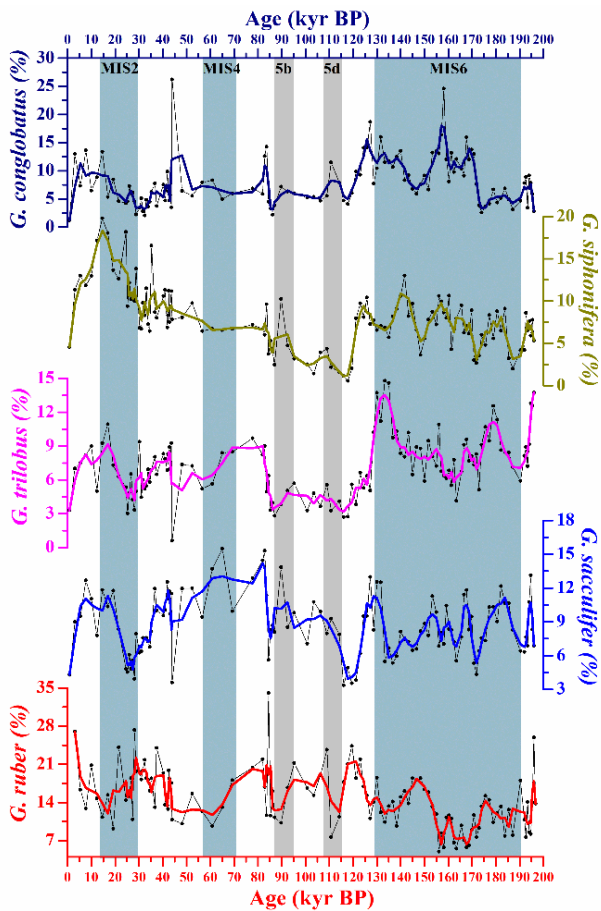


Fig. 7 - Variation of the mixed layer (*Globigerinoides ruber*, *G. sacculifer* and *G. conglobatus*) and thermocline dweller (*Neogloboquadrina dutertrei*, *Globorotalia menardii* and *G. tumida*) species of the 47-PC core during ~200 kyr.

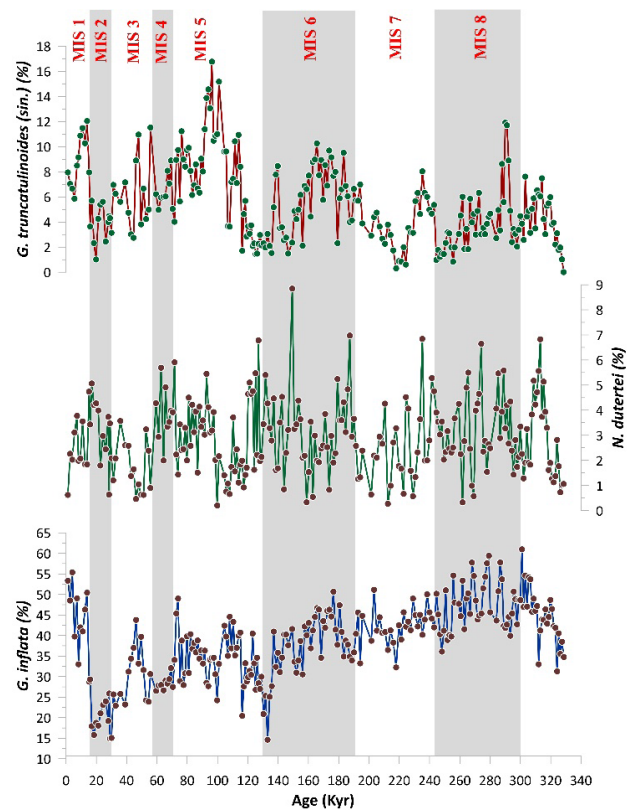
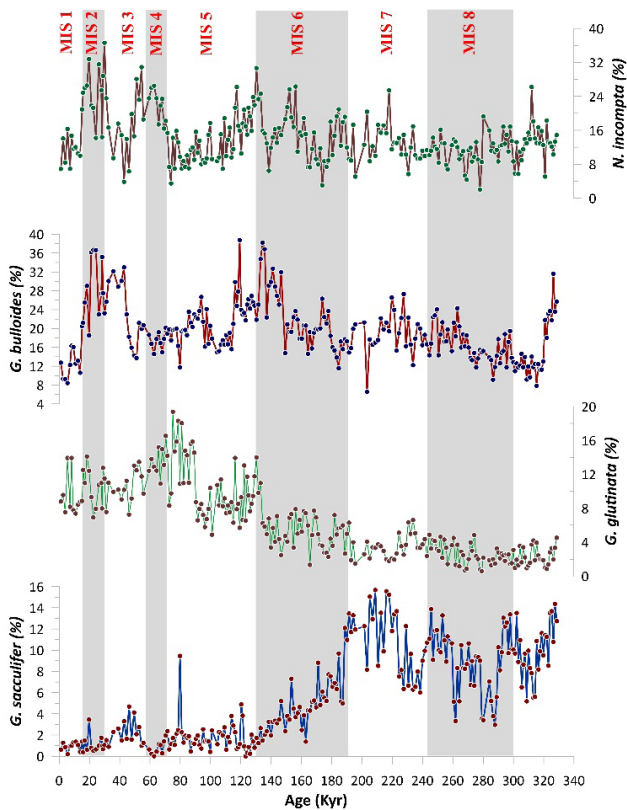


Fig. 8 - Variation in the relative abundance of the mixed layer and thermocline species of the U1475 core during the past ~357 kyr.

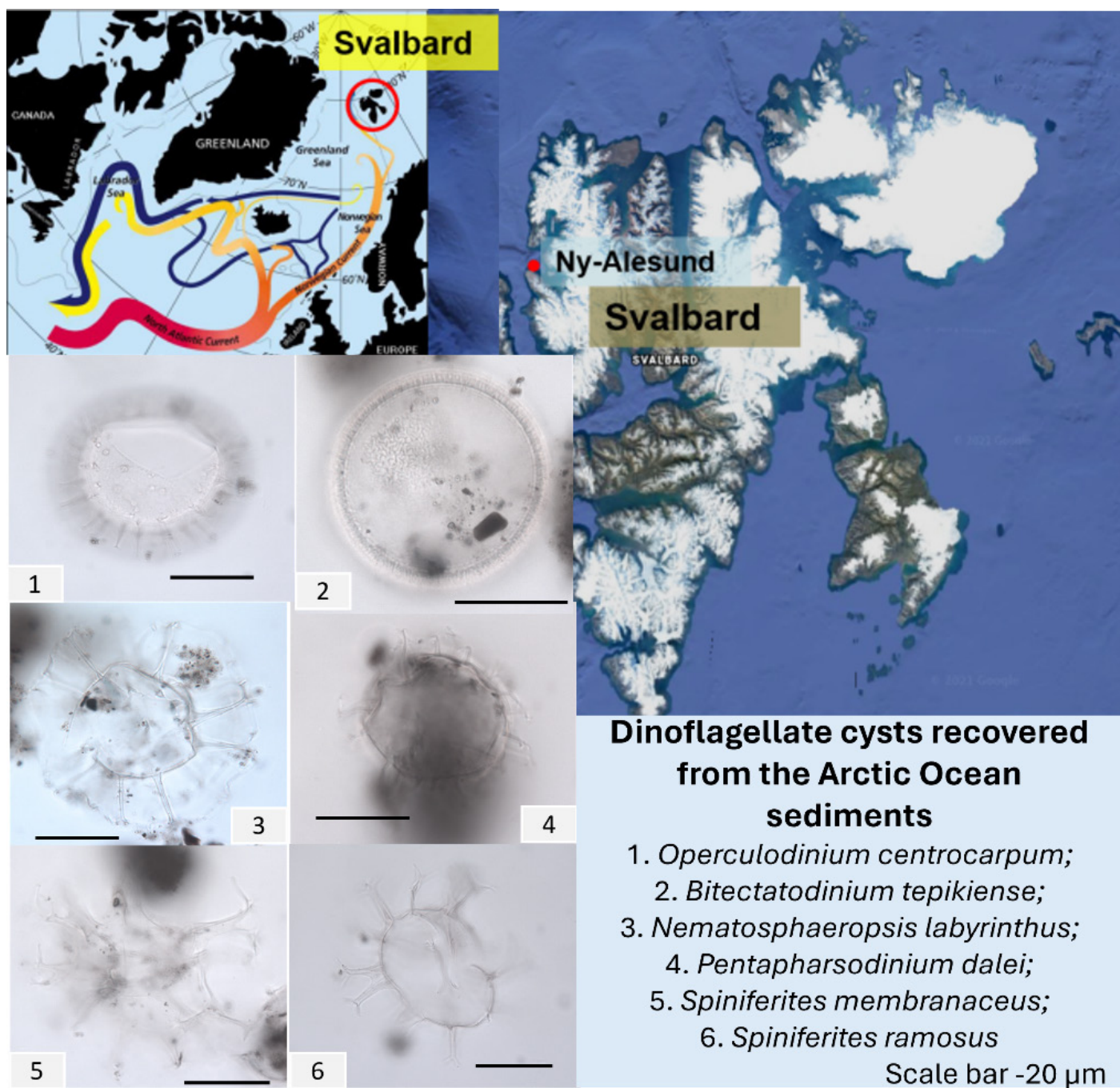


Fig. 9 - Study of preserved biotic remains from a High Arctic Pond in Svalbard, Norway.

are among the dinoflagellate cysts in the last interglacial Arctic sediment samples.

Benthic foraminifers have been recovered from the late Quaternary sequence of the Svalbard region. *Elphidium excavatum*, *Cibicides lobatulus*, *Cassidulina laevigata*, *C. neoteretis*, *C. reniforme*, *Islandiella helenae* and *I. norcrossi* are in the assemblage. Complete and robust shells imply in-situ preservations of the foraminifers.

Antarctica:

The proglacial lake P-11 core from the Schirmacher Oasis was studied to understand the palaeoenvironmental/

palaeoclimatic changes taking place in and around the study area. Isotopic data reveals the increase in the contribution of phytoplankton during ~ 14 ka to 7.5 ka, and thereafter gradual lowering of isotopic values during ~7.5 ka to 3 ka, which suggests the input of organic matter from mosses/ lichens (Fig. 10).

PROJECT OUTCOME

Publications in SCI (Science Citation Index) Journals

1. Shukla SK, Crosta X & Ikehara M 2023. Synergic



P 11

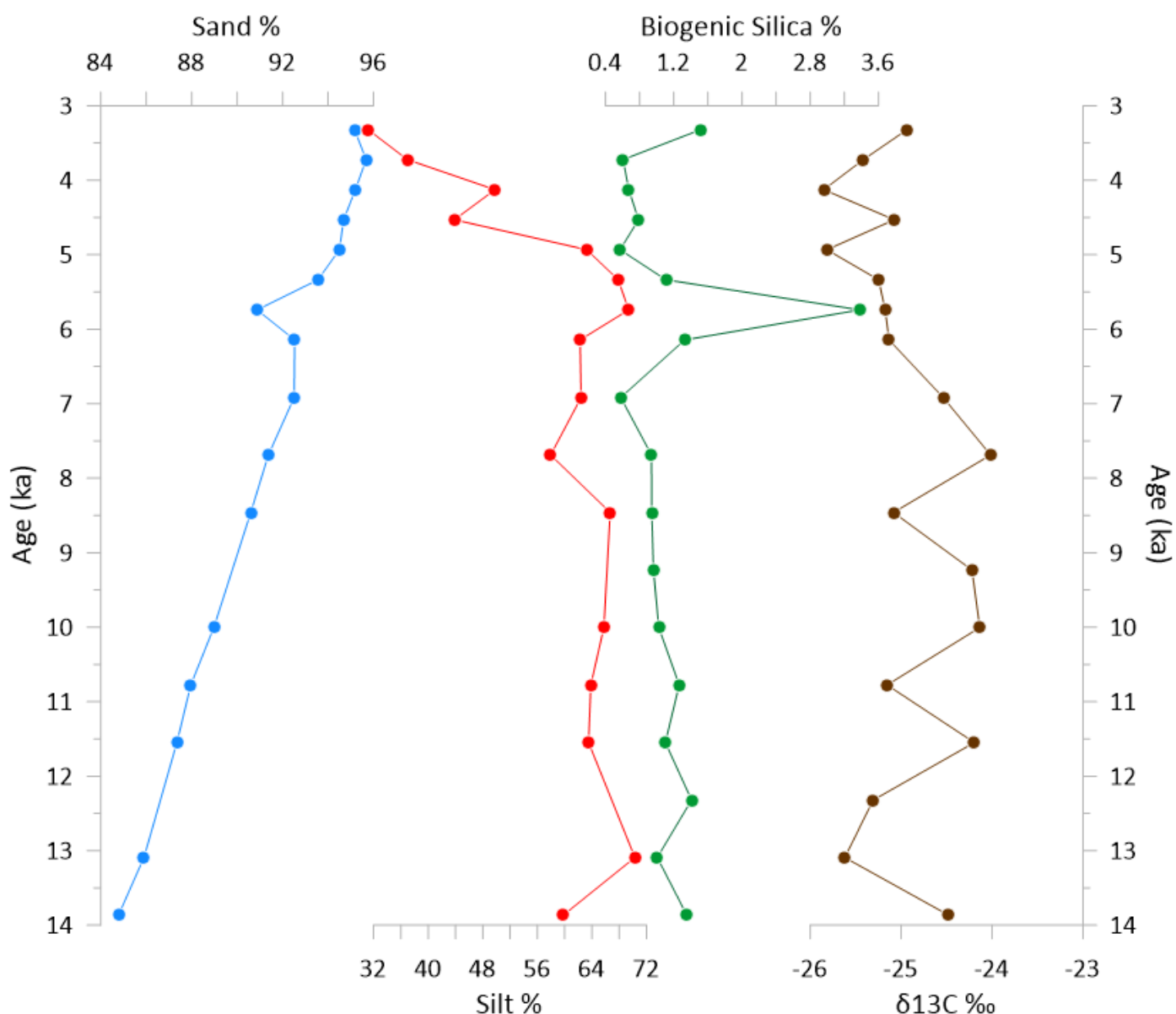


Fig. 10 - Grain size, biogenic silica and carbon isotope data from P-11 core of Schirmacher Oasis (East Antarctica).

role of frontal migration and silicic acid concentration in driving diatom productivity in the Indian sector of the Southern Ocean over the past 350 ka. *Marine Micropaleontology* 181: 102245. <https://doi.org/10.1016/j.marmicro.2023.102245> (IF- 1.9).

Refereed Non-SCI Journals

1. Verma D, Govil P, Kumar B & Khan H 2023. Variation in dynamics controls and impacts of Agulhas Leakage through Late Pleistocene: A Review. *Journal of Palaeosciences* 72: 43-54.

Book Chapters/Memoirs/Bulletins

1. Kawsar M & Manoj MC 2023. A technical note on sediment End Member Modelling Analysis (EMMA) and its interpretation in the past climate reconstruction. *Palaeosciences Souvenir – Birbal Sahni Institute of Palaeosciences Hindi Magazine* 2: 75-81.
2. Chakraborty A, Ghosh AK, Saxena S, Dey R & Roy L 2023. Neogene biostratigraphy and paleoceanography of Andaman and Nicobar Basin: A reappraisal. *Stratigraphy & Timescales*. 8: 122-169 (ISSN 2468-5178). Elsevier. <https://doi.org/10.1016/bs.sats.2023.08.005>.

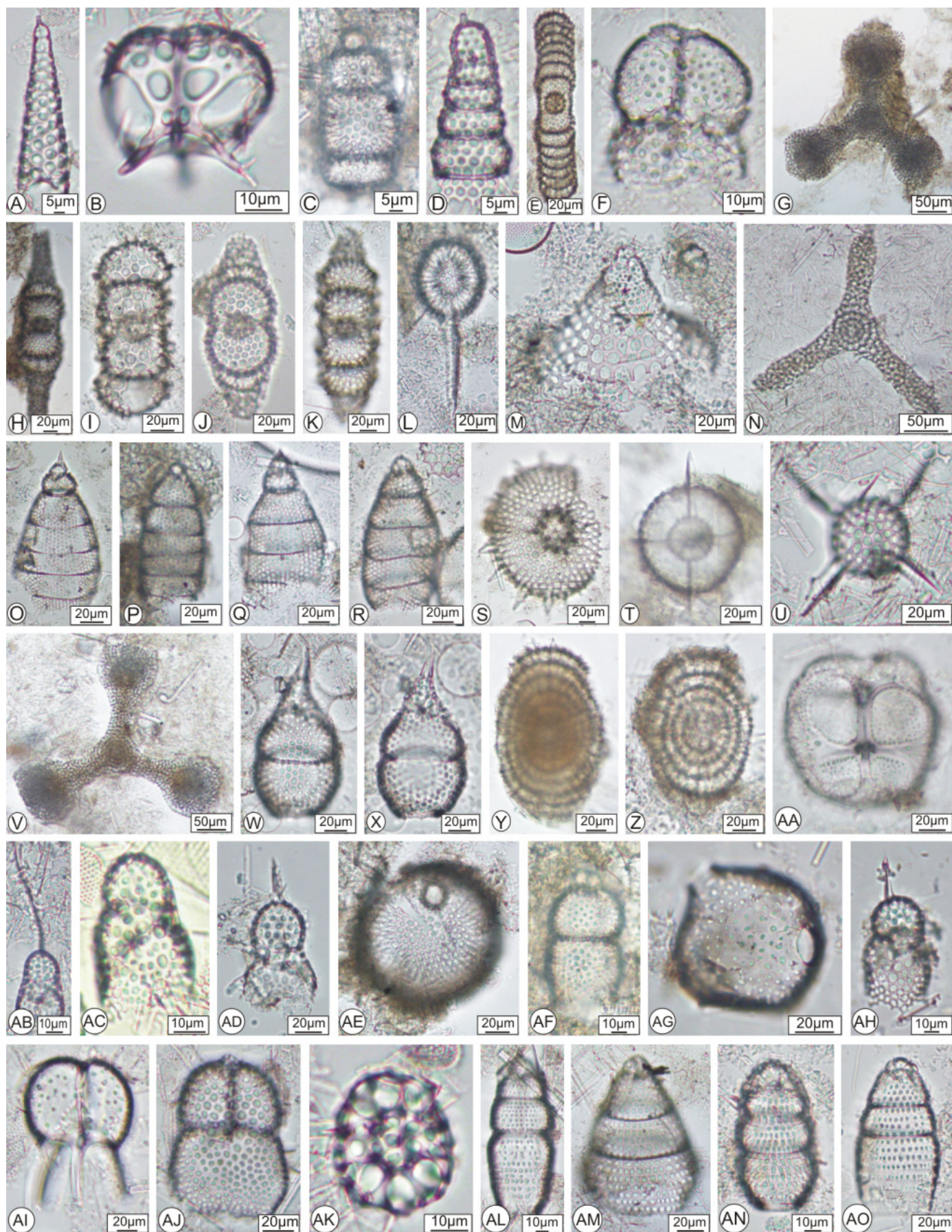


Fig. SP. 4.1(a) – (A) *Cornutella profunda*, (B) *Corythospyrisreuschi*, (C) *Cyrtocapsellacornuta* (D) *Cyrtoperalaguncula*, (E) *Diartushughesi*, (F) *Dendrospyris* sp., (G) *Dictyocoryne profunda*, (H) *Didymocyrtis antepenultima*, (I) *Didymocyrtisavita*, (J) *Didymocyrtislaticonus*, (K) *Didymocyrtis penultima*, (L) *Druppattractus nanus*, (M) *Euecryphalus* sp., (N) *Euchitonia elegans/furcata* Group.



General Articles/Reports/Database Published

1. Phartiyal B, Tripathi S & Manoj MC 2023. XXI INQUA Congress 2023 Rome, Italy: India's successful bid to host the INQUA Congress in 2027. *Journal of Palaeosciences* 72(2): 175-178.
2. Manoj MC 2023. Indian Participation in XXI INQUA Congress 2023, Rome, Italy. *Quaternary Chronicle* 5(2): 8.

Publications Other than the Project

1. Agarwal S, Shukla SK, Srivastava P & Sundriyal Y 2023. Peat sequence diatoms from Kedarnath, Central Himalaya, used to reconstruct mid-late Holocene hydroclimatic conditions. *Palaeogeography, Palaeoclimatology, Palaeoecology* 612: 111381. <https://doi.org/10.1016/j.palaeo.2022.111381> (IF: 3).
2. Dey R, Basso D, Chakraborty A, Roy L, Bhaumik AK & Ghosh AK 2023. Rhodolith forming coralline red algae in the CaCO₃ biofactory — A case study from the Serravallian of tropical northeastern Indian Ocean. *Comptes Rendus Palevol* 22(26): 541-567. <https://doi.org/10.5852/cr-palevol2023v22a26> (IF: 1.1).
3. Farooqui A, Khan S, Agnihotri R, Phartiyal B & Shukla S 2023. Monitoring hydroecology and climatic variability since ~4.6 ka from palynological, sedimentological and environmental perspectives in an Oxbow lake, Central Ganga plain, India. *The Holocene* 33(10): 1272-1288. <https://doi.org/10.1177/09596836231183067> (IF: 2.4).
4. Kawsar M, Manoj MC & Weber ME 2023. Depositional dynamics of the Bengal Fan since the Late Miocene: Discrimination of skin friction shear stresses of hemipelagic vs. turbiditic deposition. *Geo-Marine Letters* 43: 19. <https://doi.org/10.1007/s00367-023-00759-w> (IF: 2.1).
5. Khan H, Govil P, Panchang R, Agrawal S, Kumar P, Kumar B & Verma D 2023. Surface and thermocline ocean circulation intensity changes in the western Arabian Sea during ~172 kyr. *Quaternary Science Reviews* 311: 108-133. <https://doi.org/10.1016/j.quascirev.2023.108133> (IF: 4.0).
6. Khan H, Govil P, Panchang R, Agrawal S, Kumar P, Kumar B & Verma D 2024. Abrupt intensification of AMOC and monsoonal winds during mid-MIS4 (Heinrich Event 6) in the western Arabian Sea. *Global and Planetary Changes*: 104398 <https://doi.org/10.1016/j.gloplacha.2024.104398> (IF: 4.0).
7. Manoj MC, Thakur B & Uddandam PR 2023. Controls on rare earth elements distribution over the past 2000 years from Kerala Coast, southwest India.

Environmental Forensics 24(1-2): 28-43. <http://dx.doi.org/10.1080/15275922.2021.1940383> (IF: 1.8).

8. Roy L, McCartney K, Ghosh AK, Bhaumik AK & Sensarma S 2023. Tortonian silicoflagellates from the offshore of northeast Indian Ocean. *Deep-Sea Research-II*, 210: 105297. <https://doi.org/10.1016/j.dsr2.2023.105297> (IF: 3).
9. Shukla SK, Chaddha APS, Kumar K, Sharma A, Pandey SK, Kapur VV, Phartiyal B, Shivam A, Dabhi A & Bhushan R 2023. Hot spring diatoms are linked to extreme cold conditions: A new perspective for astrobiological implication from the sinter deposit of Puga hot spring, Ladakh, India. *Authorea Preprints* (2023/12/3).

SPONSORED PROJECTS (SP) AND COLLABORATIVE PROJECTS (CP)

SP 4.1: Neogene climate change vis-à-vis major climatic events: a quantitative reconstruction from northeast Indian Ocean (CSIR Emeritus Project No. ES2021Y8027) [21(1143)/22/EMR-II].

Investigators: Amit K. Ghosh (Emeritus Scientist - CSIR)

The sediment core recovered during the NGHP Expedition-01 drilling program from the northeastern Indian Ocean near Andaman back arc basin (10° 45.1912'N, 93° 6.7365'E) were analyzed to study radiolarians. Seventy-one samples from 684.09-220.37 mbsf have been analyzed in the study. The preservation potentials of radiolarians are moderate to good. One hundred and fifty radiolarian taxa belonging to 75 genera have been recorded, of which 68 taxa have been identified up to the species level. The radiolarian biostratigraphy indicates the presence of RN6-RN9 zones of Sanfilippo and Nigrini (1998) that have been recognized based on the index radiolarian taxa, i.e. *Didymocyrtes laticonus*, *D. antepenultima*, *D. penultima*, *D. avita*, *Diartus hughesi*, *Stichocorys delmontensis*, *S. peregrina*, *Phormostichoartus doliolum*, etc. based on the index radiolarian taxa late Miocene (Tortonian-Messinian: 9.86-5.98 Ma) age for 684.09-220.37 mbsf depth interval has been estimated. The radiolarian assemblages are also represented by some stratigraphically significant taxa, namely *Siphocampe lineata*, *Tetrapyle octacantha*, *Acrobotrys tritubus*, *Botryostrobus miralestensis*, *Spongaster berminghami*, *Solenosphaera omnitubus*, *Siphostichartus corona*, *Pterocorys campanula*, etc. Some of the radiolarian forms are illustrated in (Fig. SP. 4.1(a)). The Nassellarian/Spumellarian ratio of radiolarians (Nassellarian: 64.05% and Spumellarian: 35.95%) shows dominance of nassellarians that indicates an overall deep-water environment (Fig. SP 4.1(b)).

SP 4.2: Late Miocene to Pleistocene palaeoclimate reconstruction based on high resolution biotic proxies coupled with geochemical analysis from the sediment cores of northeast Indian Ocean (Project No. DST-INSPIRE (IF180254) (April 01, 2023 to September 10, 2023).

Investigators: Lopamudra Roy, DST-INSPIRE, SRF & Amit K. Ghosh (Emeritus Scientist-CSIR), Mentor

The Ph. D. thesis has been compiled based on the studies of silicified and calcified microfossils, e.g. diatoms, radiolarians, silicoflagellates and calcareous nannofossils from the late Miocene to Pleistocene sequence of the sediment core in the northeast Indian Ocean to develop a high resolution multiple microfossil biochronology. A synergistic approach was employed based on the evidence of microfossils coupled with the geochemical signatures for accurate interpretation of palaeoecology, palaeoclimate, depositional environment and overall paleoceanography that may be useful as a benchmark to predict future climatic changes. An in-depth study based

on the multiple microfossil bio-events provides a clear picture of the palaeoenvironment during the late Miocene to Pleistocene. Based on the study of the Miocene to Pleistocene sequences, the precise age of the sediments has been determined and significant climatic events have been identified. The Ph. D. thesis was submitted on July 2023 and awarded on January 04, 2024, by the University of Lucknow.

OTHER ACADEMIC WORKS

Research Papers Presented

1. Manoj MC, Krishna KA, Crosta X, Shukla SK & Kawsar M – 2023. Glacial-interglacial ice-rafted debris variability in the western Indian sector of the Southern Ocean: Palaeoceanographic implications. XXI INQUA Congress 2023. Rome, Italy, July, 2023.
2. Manoj MC, Crosta X, Shukla SK, Kawsar M & Krishna KA – 2023. Ice-rafted debris variability from the western Indian sector of the Southern Ocean over the past 650 ka. National Conference on Polar Sciences (NCPS - 2023), Goa, India. May 2023.
3. Shukla SK, Mohan R, Crosta X, Mishra A, Michel E & Mazaud A - 2023. "High-resolution record of sea surface temperatures in the Indian sector of the Southern Ocean since ~26 kyr. National Conference on Polar Sciences 16th – 19th May, 2023 at National Centre for Polar and Ocean Research, Vasco-da-Gama, Goa.
4. Samal P, Singarasubramanian SR, Manoj MC, Srivastava J, D'Souza N, Balakrishna K, Chauhan Md M & Ali S - 2023 Assessment of heavy metal pollution and human risk in the Mahanadi River sediments, India. Goldschmidt 2023 Conference. July 2023.
5. Ghosh AK - 2023. Mathematical attributes applicable on the evolution of life forms and their adaptation with changing climate in the geologic past. 2nd International Conference on Mathematical Analysis and Applications in Modeling (ICMAAM 2023) held during 09-11 September, 2023, organized by Centre for Mathematical Biology and Ecology, Department of Mathematics, Jadavpur University, Kolkata (Invited Lecture).

Deputation to Conferences/Seminars/Workshops (both online and offline)

Manoj MC, KA Krishna, X Crosta, SK Shukla & M Kawsar

- Glacial-interglacial ice-rafted debris variability in the western Indian sector of the Southern Ocean:

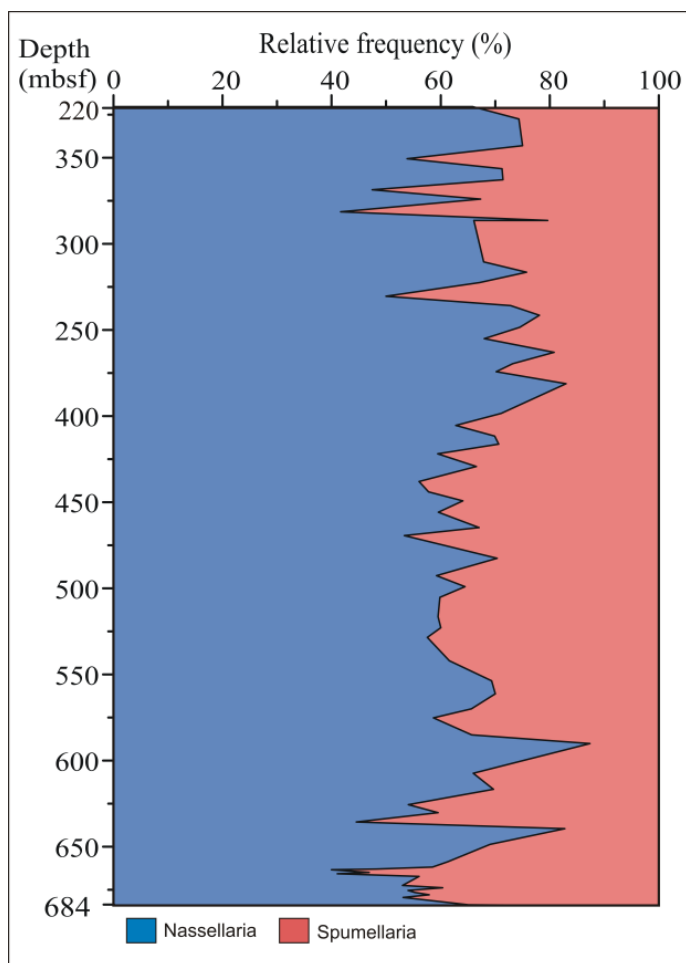


Fig. SP 4.1(b) – Nassellaria / Spumellaria ratio of radiolarians from NGHP-01-17A.



PH.D. PROGRAMMES

	Masud Kawsar (2020). The Bengal Fan evolution through Neogene and Quaternary: Implication for deep ocean circulation, productivity, and monsoonal shifts, under the supervision of Manoj MC (BSIP) and Micheal E Weber, the University of Bonn, Bonn, Germany, Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: Awarded .
	Amulya Saxena (2016). Phytodiversity and climate fluctuation in and around wildlife sanctuaries of Assam since late Holocene: A geological and palynological aspects, under the supervision of Abhijit Mazumder (BSIP) and Dhruv Sen Singh (LU) registered with Lucknow University. Status: Awarded (July, 2023).
	Hidayatullah Khan (2020). Reconstruction of Palaeoceanography of tropical Indian Ocean since Marine Isotopic Stages 5, under the supervision of Pawan Govil (BSIP) and Rajani Panchang (Pune University), registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: Submitted.
	Brijesh Kumar (2020). Late Quaternary palaeoceanographic reconstructions from the Equatorial Indian Ocean: emphasis on Indian Ocean dipole, under the supervision of Pawan Govil (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Divya Verma (2020). High resolution reconstruction of paleoceanography and paleoclimatology of the south-west Indian Ocean during Late Quaternary, under the supervision of Pawan Govil (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Sneha Mary Mathew (2020). Paleocene–Eocene records of palaeohydrological and palaeoenvironmental changes from the lignite fields of Rajasthan, India, under the supervision of Manoj MC (BSIP) and Shailesh Agrawal (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Shubham Mishra (2022). Reconstruction of the palaeomonsoon and palaeoclimate during the Holocene using lake sediments from western India, under the supervision of Manoj MC (BSIP) , registered with Academy of Scientific & Innovative Research. Status: In-progress.
	Saleesh PN (2023). Lacustrine sediment records of late Quaternary climate and sea level from the coasts of south India, under the supervision of Manoj MC (BSIP) , registered with the University of Calicut. Status: In-progress.
	Lopamudra Roy (2019). Reconstruction of late Miocene to Pleistocene palaeoclimate using micropalaeontology and geochemical analysis from the sediment core of northeast Indian Ocean, under the supervision of Amit K. Ghosh (BSIP) and Sarajit Sensarma (University of Lucknow), Status: Awarded (January 04, 2024).

Palaeoceanographic implications. XXI INQUA Lectures delivered
Congress 2023. Rome, Italy, July, 2023.

Amit K. Ghosh (Emeritus Scientist)

- 2nd International Conference on Mathematical Analysis and Applications in Modeling (ICMAAM 2023) held during 09-11 September, 2023, organized by Centre for Mathematical Biology and Ecology, Department of Mathematics, Jadavpur University, Kolkata.
- 2nd Botanical Congress 2024 on 23rd and 24th of March 2024 in Burdwan University, Burdwan, West Bengal.

Amit K. Ghosh

- Mathematical attributes applicable on the evolution of life forms and their adaptation to changing climate in the geologic past. 2nd International Conference on Mathematical Analysis and Applications in Modeling (ICMAAM 2023) held during 09-11 September 2023, organized by the Centre for Mathematical Biology and Ecology, Department of Mathematics, Jadavpur University, Kolkata (Invited Lecture).



- Major climatic events during the last 23 million years: evidence from the fossilized marine phytoplankton of Andaman and Nicobar Islands. One-Day International Seminar on Research Methodology in Marine Microbiota: Past & Present, B. B. College, Asansol. February 12, 2024 (Guest Speaker).

CONSULTANCY/TECHNICAL SUPPORT RENDERED

Pawan Govil (Geochemistry Lab)

- A number of samples on ICP-MS in the laboratory have been analyzed. Samples are largely of soil and sediments collected from terrestrial realms, including glacier, fluvial and lacustrine nature. Besides routinely used international standard protocols, efforts are made to develop protocols for tough samples. The facility receives samples from different parts of the country on consultancy basis. We have generated approximately Rs. 4,47,440/- through the Consultancy. Besides Consultancy, In-House project samples were also analyzed and provided the data to the concerned lab/scientist.

ACCOLADES RECEIVED

Pawan Govil

- Received a six-month Matsumae International Fellowship to JAMSTEC, Japan, in December 2023. The availing time will be from November 2024 to April 2025.

REPRESENTATION IN COMMITTEES/BOARD

Pawan Govil

- Secretary - "The Palaeobotanical Society, India" from 2022 to the present.
- Member of PhD Doctoral Advisory Committee (DAC) and Comprehensive Examination for the AcSIR students (Mr. Arif Ansari, Mr. Masud Kawsar, Mr. Guru Sewak and Mr. Katange)

Manoj MC

- Member of PhD candidate Screening and Selection Committee for AcSIR - Academy of Scientific & Innovative Research (January 2023 - August 2023 session)
- Member of PhD Doctoral Advisory Committee (DAC) and Comprehensive Examination for the AcSIR students (Ms. Divya Verma, Mr. Hidayatulla, Mr. Brijesh Kumar, Piyal Halder, Harsh Kumar & Arif Ansari)
- Member of the Doctoral Advisory Committee (DAC) of Ms. Yamuna Sali, A.S., Manipal Institute of Technology, Manipal.

Vartika Singh

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

Sunil Kumar Shukla

- Member of PhD Doctoral Advisory Committee (DAC) for the AcSIR students Ms. Divya Verma and Mr. Brijesh Kumar.

Amit K. Ghosh (Emeritus Scientist)

- Member, National Scientific Advisory Committee, 2nd International Conference on Mathematical Analysis and Applications in Modeling (ICMAAM 2023) held during 09-11 September, 2023, organized by Centre for Mathematical Biology and Ecology, Department of Mathematics, Jadavpur University, Kolkata and Chaired a Scientific Session.
- Advisory Editor, Journal of Environmental Biology (Palaeobiology & Past Climatology).
- Chaired a Scientific Session at the 2nd Botanical Congress 2024 on 23rd and 24th of March 2024 at Burdwan University.



Project 5: Biological and Biogeochemical changes during Late-Quaternary from Coastal regions of India: Insights into Coastal Dynamics and Monsoonal Variability

COORDINATOR: BISWAJEET THAKUR (SCIENTIST E)

CO-COORDINATOR: SHILPA PANDEY (SCIENTIST E)

OBJECTIVES

- To assess palaeoproductivity, palaeovegetation and relative sea-level changes using biotic– abiotic interactions.
- To assess variability in governing factor(s) for SW & NE monsoonal strength and coastal ecology.
- To evaluate relative roles of continental versus marine factors in governing climatic cycles/ transitional periods.
- To delineate controls of climate-tectonic forces on fluvio-marine processes with respect to sea level fluctuations/changes in palaeogulf settings.

PREAMBLE

The Coastal Core Project was established with the aim of comprehending the intricate biogeochemical interactions among the biosphere, atmosphere, and hydrosphere. Coastal sediments serve as crucial repositories, offering insights into both regional and global climate phenomena. Across all aquatic environments, whether inland or coastal, adverse transformations have been observed due to escalating industrialization and population growth in recent decades. Climate fluctuations, intensified rainfall, and human-induced pressures are among the primary drivers altering coastal ecology. These sediments play a pivotal role in elucidating ecological shifts in carbon

sequestration, as well as sea level fluctuations. Key elements like Carbon, Nitrogen, Sulfur, and Phosphorus (C, N, S, and P) serve as vital indicators for understanding biogenic productivity and coastal ecosystems. A deeper understanding of both natural and anthropogenically influenced biogeochemical cycles of these elements is imperative for risk assessment, scenario planning, and mitigating the effects of climate change. Integration of stable isotopes of C, N, S, along with biotic proxies such as pollens, diatoms, palynofacies, and phytoliths, offer conclusive evidence of past ecological shifts, impacting both geochemistry and biodiversity. By combining these proxies, we can unravel the complex biogeochemical transformations evident in both contemporary and historical sediment records. The investigation seeks to provide valuable insights into today's imbalanced and poorly managed wetland ecosystems and coastal fringe areas, serving as a critical component in addressing climate change scenarios.

PERSONNEL INVOLVED

Team Members: P. Morthekai (Scientist D), Niteshkumar Khonde (Scientist C), Sanjay Kr Singh Gahlaud (Scientist B)

Associate Members: Srinivas Bikina (Scientist F), Abhijit Mazumder (Scientist E), Arif H. Ansari (Scientist D)

Research Scholars: Pooja Tiwari, Anand Rajoriya, Jinamoni Saikia, Sangram Sahoo



1st Row (L to R): Jinamoni Saikia, Niteshkumar Khonde, Biswajeet Thakur, Shilpa Pandey, Sangram Sahoo, Pooja Tiwari; **2nd Row (L to R):** Sanjay K. Singh Gahlaud, Katange Kishor Vasant, Guru Sewak Singh, Anand Rajoriya



Fig. 1 - Major tidal network in and around the Kori Creek region for past four decades.

SIGNIFICANT FINDINGS

Using Satellite images, we mapped the all the major tidal network in and around the Kori Creek region for past four decades (Fig. 1) to understand the evolving Kori Creek region in the north and northeast direction (~32 km in total) (Fig. 2). Six short sediment cores were studied for the sediment characteristics and their mineralogical and geochemical aspects including the X-radiography and Optical Imaging. Five cores raised roughly in an N-S transect across the Kori Creek tidal network and one core from the partially open coast settings to compare the signatures of coastal sediment re-distributions (Fig. 4) with clay minerals and suggest the mixing of the Indus and Great Rann of Kachchh in the central and southern part of the transect, for which GRK and Indus delta acts as an individual end member. Along the Southeast Coast of India the Konthagailake, Sivaganga District was studied for multi-proxy evaluation of natural and anthropogenic response during the middle Holocene time period (Fig. 5). Multi-proxy investigations incorporating palynology reveal pollen from local vegetation more abundant, whereas regional vegetation is poorly represented, i.e. mangroves are locally restricted to Sambai and reflect the distributions of the source plants and mangrove types (Plate 1). However, the greatest concentrations of allochthonous taxa of evergreen and deciduous components derived from the surrounding lands are well recorded in Kondhagi and Karanpudu areas. Diatoms and palynofacies from

Arookutty core, Kerala Coast showed various limnological character for coastal dynamics during the late Holocene Period (Fig. 6).

The palynological analysis of surfaces oil samples collected from the Muthupet and Pichavaram areas of the Tamil Nadu Coast have been completed. To study the relationship between the pollen-spore data and current vegetation cover and to understand whether the palynoflora from surface sediments reflect the zonation of the standing vegetation, pollen and NPP's studies were undertaken from this lagoon. This study presents the first modern pollen, non-pollen palynomorphs data from a pristine mangrove lagoon of Thiruvavur, Tamil Nadu Coast. Results show that pollen from local vegetation more abundant, whereas regional vegetation surrounding the depositional site is poorly recorded. The statistical analysis and final interpretation are under progress.

A high-resolution palynological data from a sediment core (~2 m) from Sambai area, Ramanathapuram, Tamil Nadu has been completed and five accelerator mass spectrometry radiocarbon dates provide time control and show that sediment deposits accumulated relatively undisturbed. The preliminary interpretation based on pollen dataset reveals mangrove vegetation started to develop at different times at the three sites. Since mid-Holocene times, the mangroves covered even the most elevated area suggesting somewhat higher relative sea-levels. The pollen concentration in

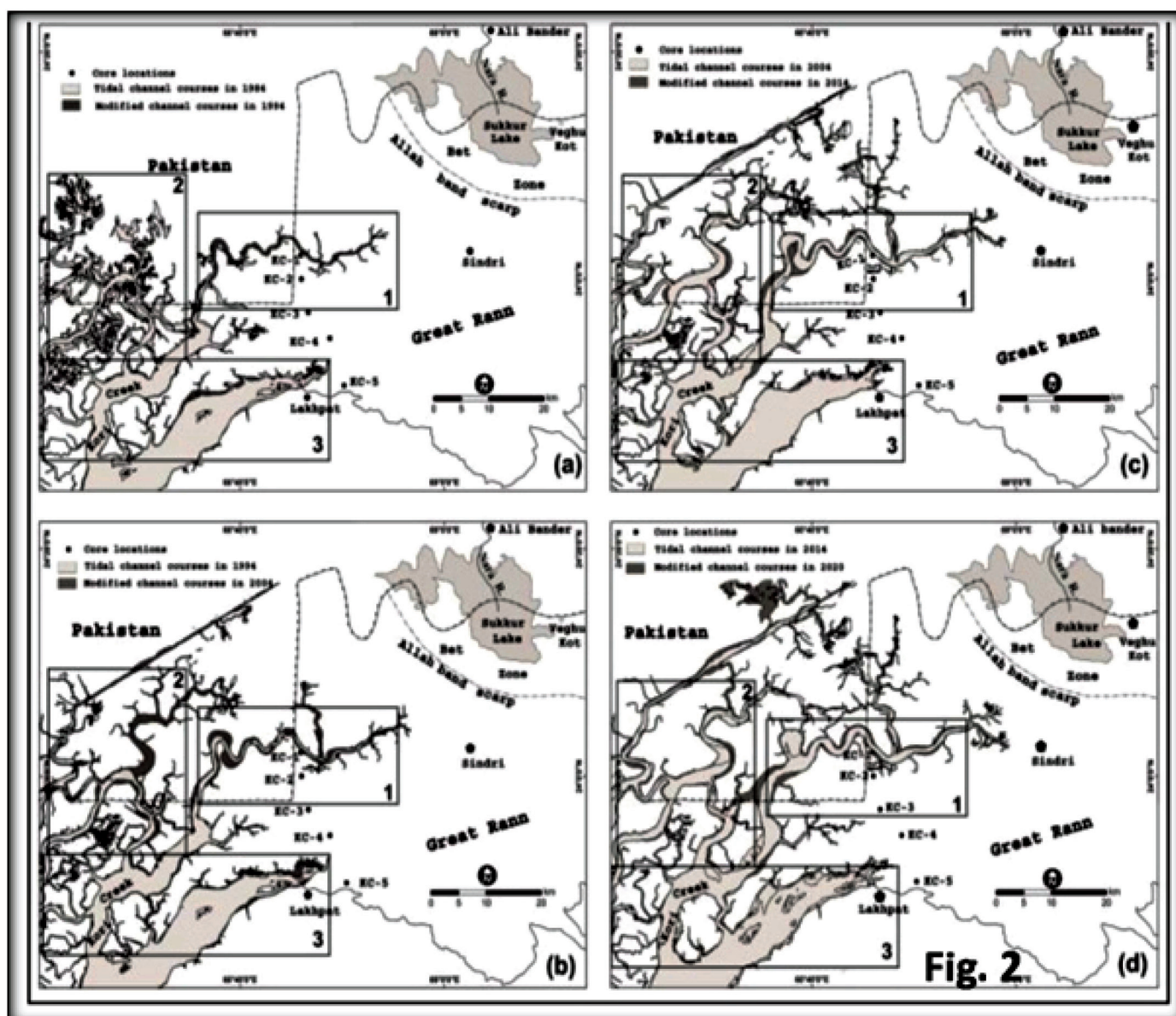


Fig. 2 - Kori Creek region in the north and northeast direction.

relatively undisturbed deposits seems to be an indicator for the frequency of inundation. The tidal inundation frequency decreased, probably related to lower sea-levels, during the late Holocene indicates change from a mangrove ecosystem to a salt marsh probably due to natural factors and not due to an anthropogenic impact. The final interpretation and other proxy data are under progress.

In addition to this, under pilot In-house project, Shilpa Pandey has carried out fieldwork in the Zaskar and Nubra valley sites and 2 short cores (~30 and 60 cm) and 1 long profile (2 m deep) were collected from the Rangdum, Hunder and Tangse areas of Leh, Trans Himalayas to study past ecological dynamics of the peatlands and also to infer long-term hydrological, peat and vegetation conditions in the Trans Himalayan region. The multiproxy analyses of the cores are under progress.

PROJECT OUTCOME

Publications in SCI (Science Citation Index) Journals

1. Khonde NK, Katange K, Singh G, Kumar A, Maurya DM, Giosan L & Ghosh T 2023. Recent sedimentation across Kori Creek in the Western Great Rann of Kachchh Basin: Insights from Tidal Network changes, sedimentological, clay mineralogical and rare earth element studies. *Journal of Coastal Research* 40(2): 289-302. doi.org/10.2112/JCOASTRES-D-23-00030.1 (IF: 1.2).
2. Tiwari P, Srivastava P & Thakur B 2024. Palynofacies and sediment texture response from sub-tropical mixed suburban to urban flood plains of the Gomati River, Lucknow, India. *International Journal of Sediment Research* 39: 276-290. doi.org/10.1016/j.ijsrc.2024.01.003 (IF: 3.6).

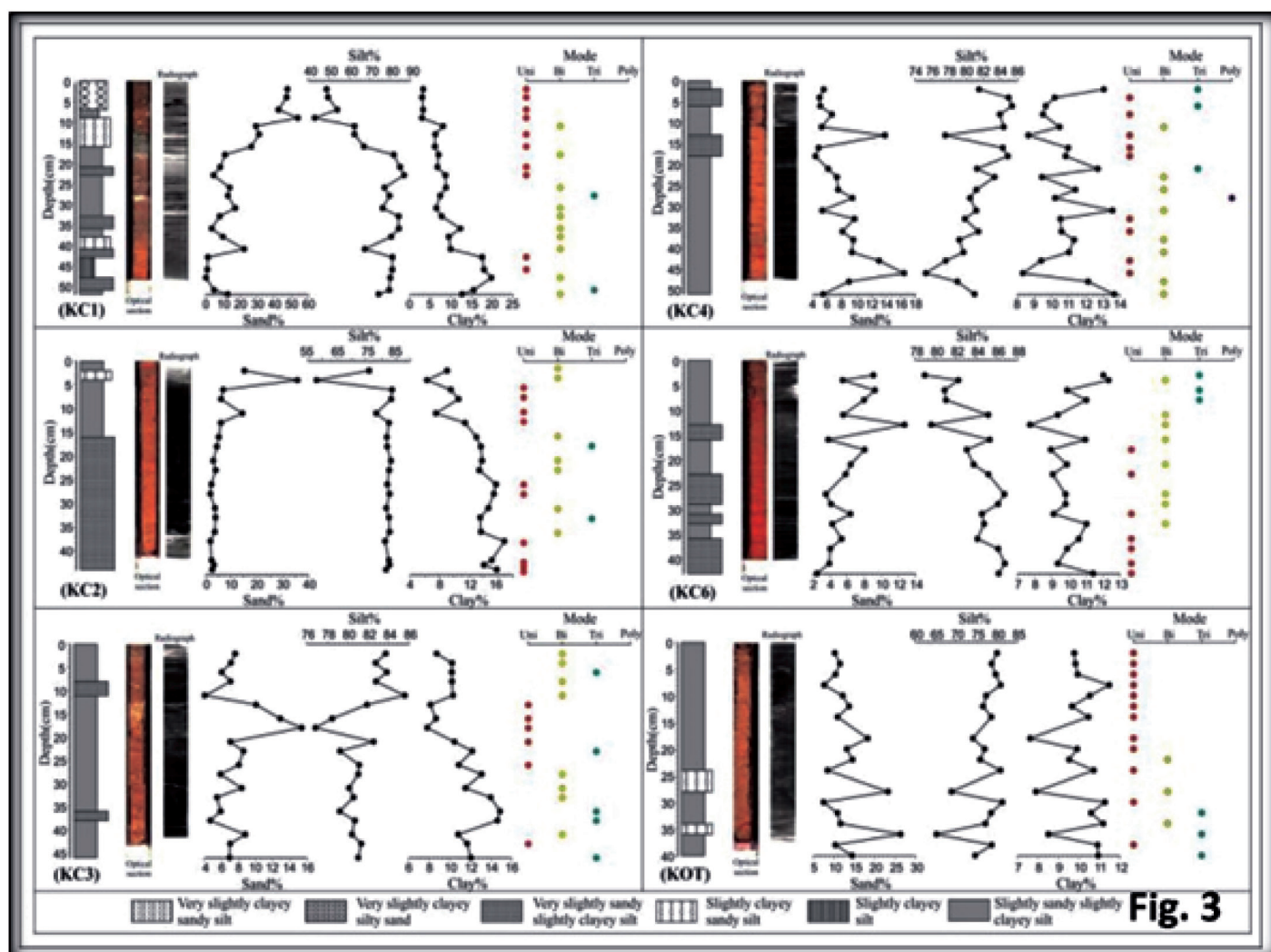


Fig. 3 - Geochemical analysis of the cores raised from the Kori Creek tidal network.

3. Tiwari P, Srivastava P & Thakur B 2023. Diatom response in different climatic zones from West Coast of India. *Journal of the Palaeontological Society of India*: 1–15. doi:10.1177/05529360231182261 (IF: 0.63).

Publication Other than the Project Work

1. Baradwal H, Ghosh A, Singh AK, Jiménez-Ballesta R, Yadav RK, Misra S, Sannagoudar S, Kumar M, Kumar RV, Gahlaud SKS, Yadav DK & Mahala DM 2023. Soil Nutrient Dynamics under Silviculture, Silvipasture and Hortipasture as alternate Land-Use Systems in Semi-Arid Environment. *Forests*: 14: 125 (IF: 2.9).
2. Sagwal S, Sengupta DK, Dutt SA, Srivastava P, Agnihotri A, Gahlaud SKS, Jena P, Shivam A & Bhushan R 2023. Late Holocene wildfire record from the Stagmo peat section, Leh Valley, NW Himalaya. *The Holocene* 33(6). doi.org/10.1177/09596836231157066.(IF: 2.4).

SPONSORED PROJECTS (SP) & COLLABORATIVE PROJECTS (CP)

SP 5.1: Holocene land-sea interactions and palaeoenvironmental changes in the Great Rann of Kachchh Basin, western India (Sponsored by SERB under Core Research Grant, New Delhi; Project No: SERB/2022/008845).

Principal Investigator: Niteshkumar Khonde (BSIP, Lucknow)

Foraminiferal studies: Foraminiferal studies were conducted on 45 samples from three raised rann sediment sequences for the generic level identification. The identification for the aeolian and fresh foraminiferal test proportions was conducted. Temporal scale variations showed significant changes in the foraminifera test size, morphological characteristics on their test surfaces depict significant changes in the palaeoenvironments. Foraminifera based chronological studies were conducted

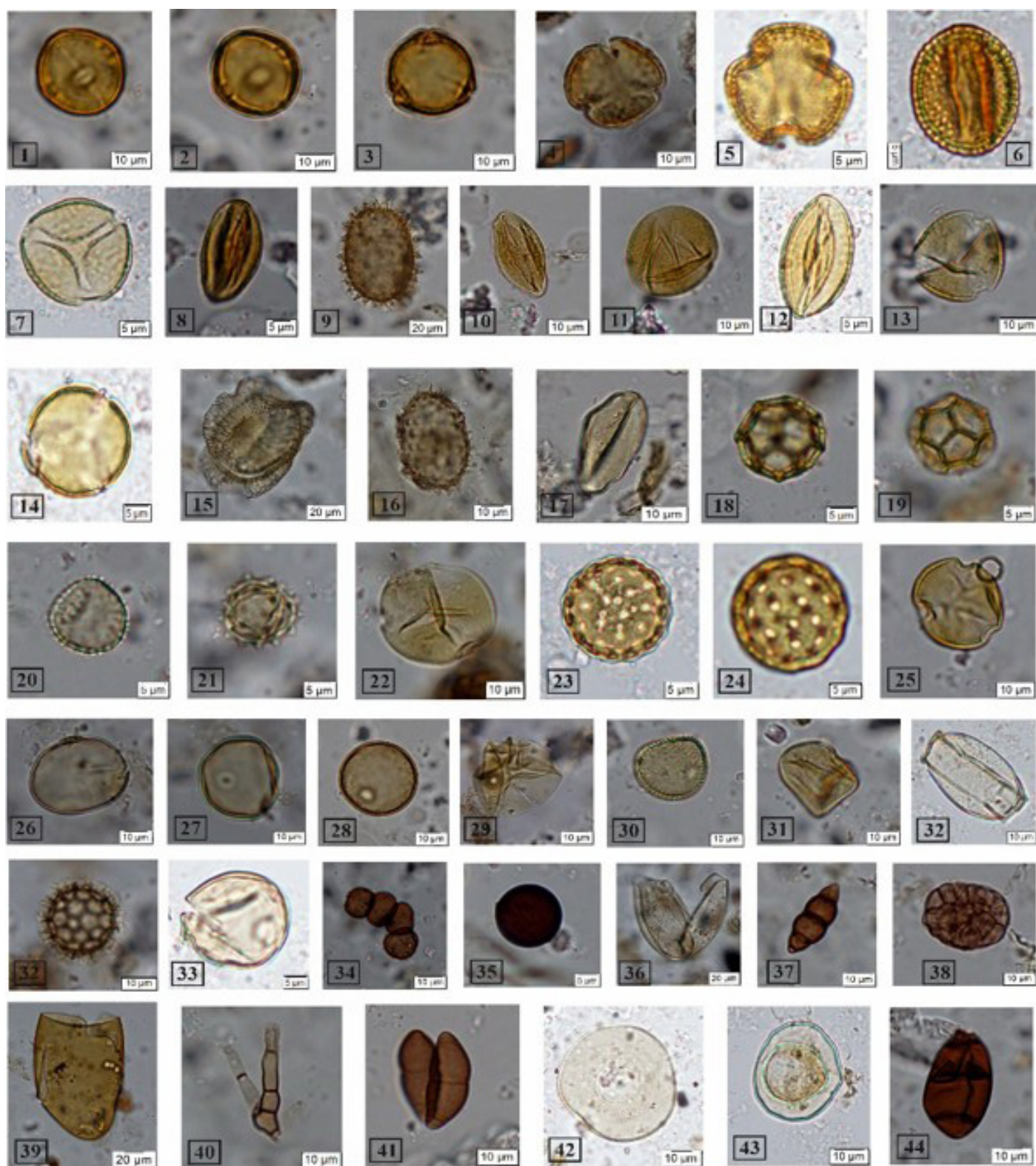


Plate 1 – Pollen distribution of mangroves from surface sediments of Karankadu to Sambai Coast, East Coast of India.

on one of the raised sediment sequence that suggests very rapid deposition of sediment during the latest Holocene in the region.

OTHER ACADEMIC WORKS

Research Papers Presented

1. Pandey Shilpa - Mangroves and Peatlands in India:

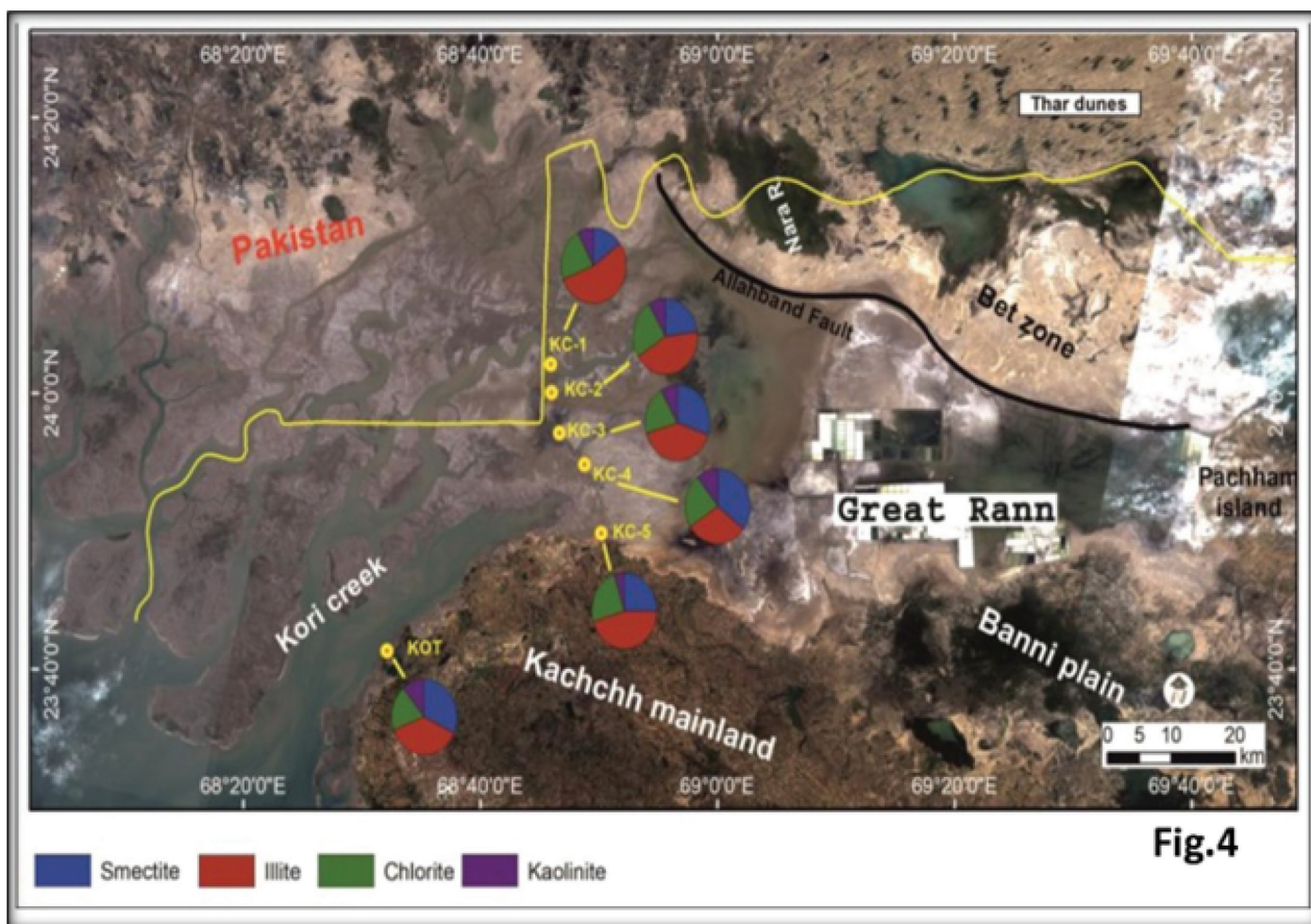


Fig. 4 - Location of cores raised in an N-S transect across the Kori Creek tidal network.

- Opportunities and Challenges, International C-PEAT Workshop at Pontianak, Indonesia, 08-11 May, 2023.
2. Tiwari Pooja, Srivastava Purnima, Gahlaud SKS, Bose T, Kumar Anurag & Thakur Biswajeet - Climatic fluctuation during ~CE 1507 to 1804 using multi-proxy records from Ashtamudi Lake, Kerala, India. National Conference on conventional, renewable energy sources and climate change perspective, from June 23-24, 2023 organized by Gondwana Geological Society, Nagpur.
3. Singh Gursewak, Katange Kishor, Khonde Niteshkumar, Saikia Jinamoni, Maurya Deepak M, Bhushan R, Jena Partha Sarthi & Dhahi Ankur -Mid-Late Holocene depositional history of the Bet Zone of the Great Rann of Kachchh: Preliminary results from ~32 m deep core. 39th Convention of Indian Association of Sedimentologists & National Conference on an innovative voyage of sedimentology: From the Himalaya to the Indian Ocean, held at Department of Earth Sciences, Annamalai University, Tamil Nadu, India.
4. Saxena Shivansh, Tiwari Pooja, Prasad Nagendra, Thakur Biswajeet & **Quamar MF**- Preliminary record of diatoms from Tuman, Korba, Chhattisgarh in Core Monsoon Zone (CMZ) of India. 7th National Geo-Research Scholars Meet (NGRSM), Wadia Institute of Himalayan Geology, Dehradun during September 11-12, 2023.
5. Rajoriya Anand, Patel Nikhil, Gahlaud SKS, Saxena Anju, Thakur Biswajeet, Bharti Nisha, Dabhi AKJ, Bhushan R & Agnihotri Rajesh - Evidences of green algae (*Botryococcus*) from past: its biogeochemical implications and potential in bioenergy. ACES 2023 at IISER Bhopal during 31 March – 1 April 2023.
6. Katange Kishor, Khonde Niteshkumar, Singh Gursewak, Maurya Deepak M, Bhushan R, Jena Partha Sarathi, Dabhi Ankur, Agnihotri Rajesh, Gahlaud SKS and Chamyal LS - Geochemical and Isotopic studies on the mid-late Holocene sediments from western Great Rann of Kachchh (GRK) Basin, western India. Goldschmidt-2023 during July 9-14, 2023.

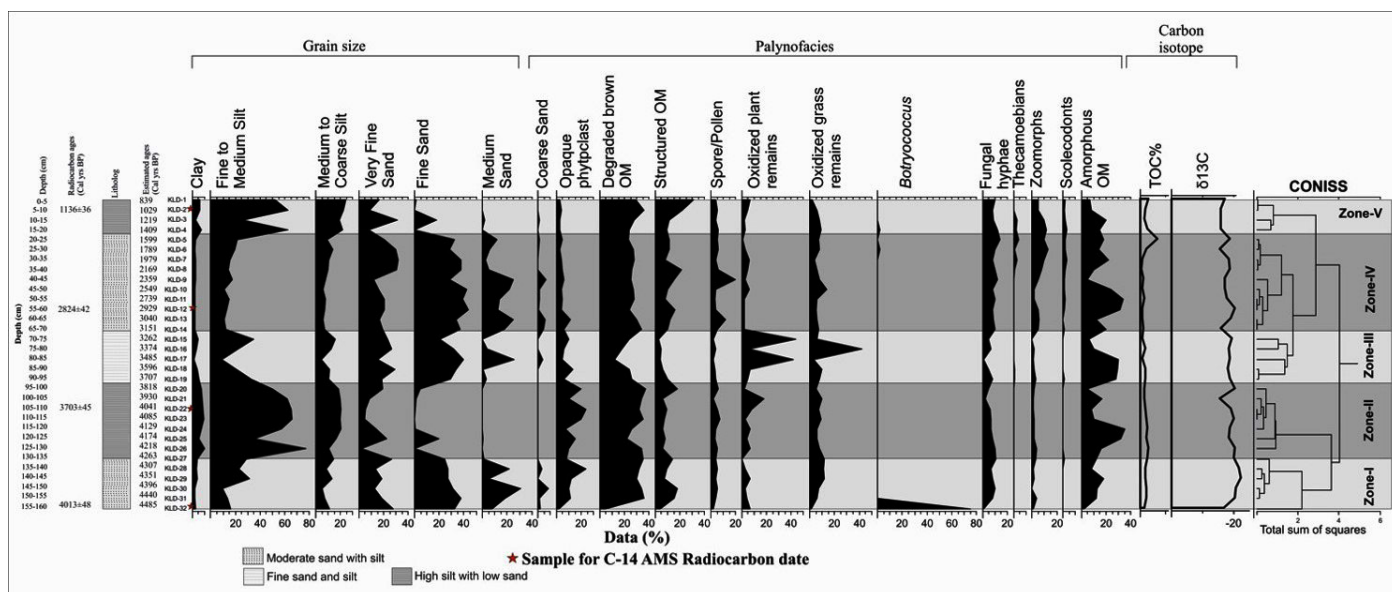


Fig. 5 - CONISS cluster analysis and zonation of grain size distribution, palynofacies, and carbon $\delta^{13}\text{C}$ of Konthagaicore, Keeladi, Tamil Nadu.

Deputation to Conferences/Seminars/Workshops (both online and offline) Training/Study Visits

Shilpa Pandey

- Deputed to attend and participate in the 9th India International Science Festival at Faridabad, Haryana during 16 to 21 January, 2024.

Shilpa Pandey

- Visited Dinofossil Park and adjoining areas Dhar areas, MP under CPGG-BSIP as Convener during December, 2023.

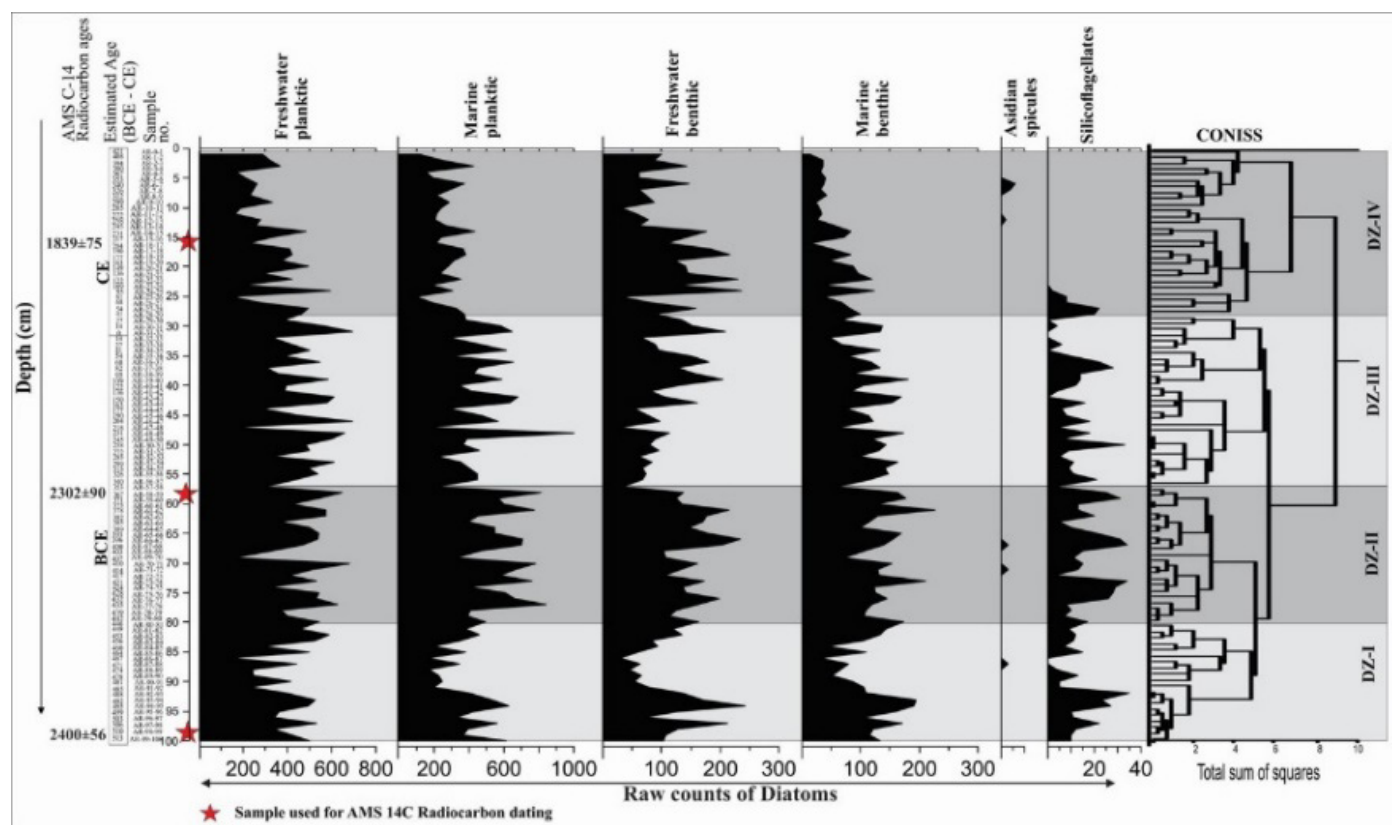




Fig. 6 - CONISS cluster analysis and zonation of diatoms and palynofacies from Arookutty Core, Kerala Coast for palaeolimnological reconstruction during the late Holocene.

PH.D. PROGRAMMES

	Pooja Tiwari (2019). Holocene climate and environment reconstruction from southwest coastal settings of Kerala using multi-proxy studies, under the supervision of Biswajeet Thakur (BSIP) and Purnima Srivastava, Geology Department, Lucknow University, Lucknow, registered with Lucknow University, Lucknow. Status: Awarded.
	Sanjay Kumar Singh Gahlaud (2018). Geochemical and stable isotopic characterization of sediments from Arabian Sea: Implications to Nitrogen and Sulfur biogeochemical cycling of Late Pleistocene – Holocene, under the supervision of Bindhyachal Pandey, registered with the Department of Geology, Banaras Hindu University. Status: In-progress.
	Nikhil Patel (2018). Geochronology and isotopic investigation of geoarchaeological remains from different archaeological sites of India implications to human environment relationship, under supervision of M.G. Thakkar (BSIP) and Alok Kumar (BHU), Varanasi, registered with Banaras Hindu University Varanasi. Status: In-progress.
	Kishor V Katange (2020). Geochemical and isotopic investigations on the high-frequency sedimentation in the Great Rann of Kachchh Basin, western India, under the supervision of Niteshkumar Khonde (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Gursewak Singh (2021). Palaeoclimatic and palaeoenvironment studies on coastal sediments from western continental margin of India, under the supervision of Niteshkumar Khonde (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Anand Rajoriya (2022). Sediments biogeochemistry with special focus on Carbon, Nitrogen, Sulfur, and Phosphorus cycling at present and in the past (late Quaternary Period) in aquatic realms of India, under supervision of Biswajeet Thakur (BSIP) registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress
	Nazakat Ali (2021). Weathering processes, provenance character and climatic manifestations during the late Quaternary from Central Ganga Plain, India, under the supervision of Biswajeet Thakur (BSIP) registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Shivansh Saxena (2022). Limnology and sedimentary organic matter characterization from Central Ganga Plain and Core Monsoon Zone of India during the late Quaternary, under the supervision of Biswajeet Thakur (BSIP) registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Vartika Singh (2022). Holocene palaeoclimate and relative sea-level changes of the Mahanadi Delta: A multiproxy approach (tentative), under the supervision of Shilpa Pandey (BSIP) and Komal Verma (BHU, Varanasi) registered with Banaras Hindu University, Varanasi. Status: In-Progress.
	Vinay K Tiwari (2022). Assessment of climate and human impact on Bakhira Bird Sanctuary, a Ramsar site of Uttar Pradesh, under the supervision of Shilpa Pandey (BSIP) and Sunita Verma (Department of Botany, Christ Church College, Kanpur) registered with Kanpur University, Kanpur. Status: In-Progress.
	Alka Rani (2022). Melissopalynological analysis of natural honeys from forests of Uttar Pradesh, under the supervision of Shilpa Pandey (BSIP) and Sunita Verma (Department of Botany, Christ Church College, Kanpur) registered with Kanpur University, Kanpur. Status: In-progress.
	Debika Deori (2021). Land-sea interactions and climate variability along coastal wetlands of the Gulf of Kachchh, western India during the Holocene: A multiproxy approach, Under the supervision of Shilpa Pandey and M G Thakkar (BSIP) registered with the Department of Earth and Environmental Sciences, KSKV Kachchh University, Bhuj. Status: In Progress.



	Jinamoni Saikia (2023). Mid-late Holocene land-marine interaction changes in the Little and Great Rann of Kachchh Basin, western India, under the supervision of Niteshkumar Khonde (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Sangram Sahoo (2023). Mangroves development and dynamics in the Sundarbans, East Coast of India since mid-Holocene: Unravelling short term impacts and long-term drivers, under the supervision of Shilpa Pandey (BSIP) registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.

Lectures delivered

Shilpa Pandey

- Delivered a lecture “Bakhira Natural Wetland as potential carbon Sink: Restoration and Protection” as Guest Speaker on 28 January, 2024 (Online).
- Delivered a lecture on “Career Prospects in Palaeosciences” at the Department of Botany, Deen Dayal Upadhyaya Gorakhpur University, Uttar Pradesh on 12 September, 2023. Also interacted and inculcated interest in UG, PG and Research Scholars about Palaeosciences studies under outreach activities.
- Delivered a lecture on “*Mangroves as solution to Climate Crisis*” International Mangrove Day organized by University of Lucknow and BBAU Lucknow on 26 July, 2023.
- Delivered a talk on “Millets as key solution to climate change and food security” in a National Workshop in Jabalpur, MP on 7 July, 2023.
- Delivered a lecture on “*Action Research in Environmental Education*” International Conference on “Educational Research in Science, Management and Humanities” organised in Lucknow Public College of Professional Studies, Lucknow on 20 October, 2023.

Niteshkumar Khonde

- Delivered a talk on, “Coastal basins and Sea level changes” in Refresher Course in Geography & Environmental Studies organised by Human Resource Development Centre, Jamia Millia Islamia University, Delhi between 26th Oct to 8th Nov, 2023.

ACCOLADES RECEIVED

Pooja Tiwari

- First Prize in Poster- Climatic fluctuation during ~CE 1507 to 1804 using multi-proxy records from Ashtamudi Lake, Kerala, India. National Conference

on conventional, renewable energy sources and climate change perspective, organized by Gondwana Geological Society, Nagpur from June 23-24, 2023.

REPRESENTATION IN COMMITTEES/BOARD

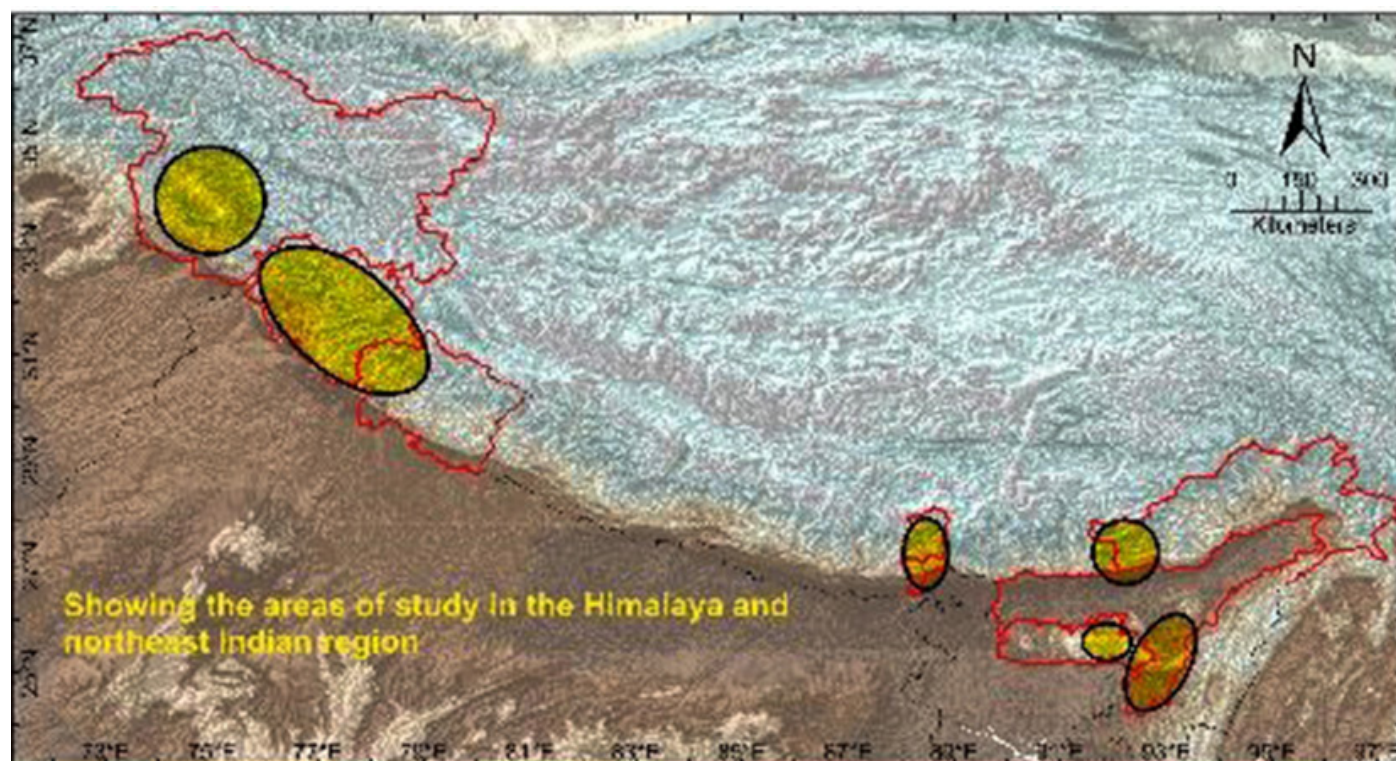
Biswajeet Thakur

- Life Member, The Palaeobotanical Society, India (since 2013)
- Life Member, Society of Earth Scientists (since 2013)
- Life Member, Earth Science India, Lucknow (since 2010)
- Executive Council Member, Palaeontological Society of India (since 2014)

Shilpa Pandey

- Vice President of International Union of Quaternary Research (INQUA) Coastal and Marine Processes Commission (2023-2027).
- Convener of Earth Science Week event by Centre for Promotion of Geoheritage and Geotourism (CPGG)-BSIP during 8-14 October, 2023.
- Empaneled as Wetland Expert by the Chhattisgarh Wetland State Authority (2023-2025).
- Member, Advisory Committee of People’s World Commission on Drought and Flood, Uttar Pradesh Commissionery including Bundelkhand in 2023.
- Life Member, Mangrove Society of India, Goa.
- Life Member, Asia Hub Representative for C-Peat Group (since July 2022)
- Life Member, Society of Environmental Sustainability
- Member, International Organization of Palaeobotany

Project 6: Late Pleistocene-Holocene vegetation and climate reconstructions for the Himalayan region: understanding the dynamics and forcing mechanisms



COORDINATOR: RATAN KAR (SCIENTIST F)

CO-COORDINATOR: S.K. BASUMATARY (SCIENTIST E)

OBJECTIVES

- To reconstruct the vegetational changes, tree-line dynamics, glacial sensitivities and abrupt hydroclimatic events during Late Pleistocene-Holocene.
- To understand the driver(s) for Holocene vegetation and climate, based on modern proxy-climate analogues.
- To trace the inception and impact of anthropogenic activities.
- To structure spatio-temporal climate reconstructions using tree-ring data of multiple taxa.

PREAMBLE

The present climate is changing at an unprecedented rate (IPCC 2018) and the mountainous regions are more susceptible to these changes as compared to other regions under the same latitudinal belt. The Holocene Epoch (the last 11,700 years) is marked by rapid climatic events (RCCs), where significant variability both in temperature and hydrological regime took place (example: 8.2 ka event, HCO, 4.2 ka event, MWP, LIA, etc). The Himalaya, especially the high-altitude region, is an exceptional repository of past climatic changes, as their signatures

are well preserved in a relatively pristine environment. The great Himalayan range is unique due to its climatic, topographic, geological and altitudinal variations. The western Himalaya is affected by both the Indian Summer Monsoon (ISM) and Western Disturbances (WDs), while the eastern Himalaya and the Northeastern region, receives precipitation only from the ISM, and is also comparatively more humid.

In order to understand the trend of climatic changes and its impact on this highly vulnerable region, long term records beyond the instrumental range are necessary. The quest of this thrust area is to understand the Holocene climatic phases in the Himalaya (and Northeastern region), at decadal to centennial scales, using biological proxy records (pollen, tree-rings, phytoliths). The inception and impact of anthropogenic activities in this ecologically sensitive region would also be looked into. Besides, the teleconnections with the mid- or high-latitude regions would also be explored.

Although, a large number of palaeoclimatic records are now available from the Himalayan region, however, in most of the cases, the underlying forcing mechanisms are yet to be explored. An understanding of the forcing mechanisms and their impact on the past ecosystems will strengthen our knowledge for simulating palaeoclimatic models, to possibly obtain insights about future climate variability and its impact on the Indian subcontinent.



PERSONNEL INVOLVED

Team Members: Santosh K. Shah (Scientist E), K.G. Misra (Scientist E), Swati Tripathi (Scientist D), S Nawaz Ali (Scientist D)

Associate Member: Parminder Singh Ranhotra (Scientist E)

Technical Support Member: Rajaram Verma (Technical Assistant B)

Research Scholars: Kajal Singh, Nidhi Tomar, Arya Pandey, Deeksha, Korobi Saikia, Ravi Shankar Maurya, Sadhana Vishwakarma, Prachita Arora, Tanveer W. Rahman, Siddhant Vaish

SIGNIFICANT FINDINGS

Studies pertaining to Holocene climatic changes, vegetation reconstruction and anthropogenic impact were undertaken along an altitudinal transect (2700 to 3600 masl) in the Chopta-Tungnath region of western-higher Himalaya (Fig. 1). Three distinct vegetation zones can be demarcated due to the steep altitudinal gradient, which in ascending order are: (i) Mixed temperate forest, (ii) Sub-alpine forest and (iii) Alpine scrub and meadows. Palynological analysis of samples from a trial-trench in the Mixed temperate forest zone, has brought out the vegetation and climatic changes in the area during the Late Holocene. Modern palynological analogues generated earlier in the area, are well compatible

with the fossil pollen assemblages. Among the important pollen taxa, *Pinus* is over-represented, while *Quercus* and *Rhododendron* are proportionally represented. The global climatic events, such as the 4.2 ka event, Roman Warm Period (RWP), Medieval Climatic Anomaly (MCA), Little Ice Age (LIA) and the Current Warm Period (CWP) are well represented. Anthropogenic indicators are also well-marked, especially through the increasing frequencies of coprophilous fungi over the last 1000 years (Fig. 2).

65 surface soil and moss cushion samples were pollen analysed to understand the modern pollen deposition in relation to the different vegetation types (Pine, evergreen and mixed deciduous forest) in the west Khasi Hills of Meghalaya (Fig. 3). Pine forest is characterised by the presence of 55% pine pollen in the palynoassemblage and other arboreals associates, such as *Betula*, *Alnus*, *Schima* and *Cinnamomum* are also regularly observed in the pollen assemblage. Evergreen forest was characterised by the dominant of evergreen elements, chiefly *Schima*, *Mesua*, *Castanopsis* and *Elaeocarpus* within the ranges of 35-45%. Among non-arboreal taxa, such as *Impatiens*, *Asteroidae*, *Euphorbiaceae* and *Piperaceae* are also consistently exhibited in the palynoassemblage. Presence of evergreen elements along with *Nepenthes* and *Impatiens* pollen in the assemblage is indicative of the high monsoonal activity in the region. The *Schima-Syzygium-Gmelina-Nepenthes-Impatiens* assemblage is characterised in the mixed deciduous forest (Manuscript is under progress).



(L to R): Parminder Singh Ranhotra, S. Nawaz Ali, K.G. Misra, Ratan Kar, Sadhan K. Basumatary, Santosh K. Shah, Swati Tripathi



Fig. 3 - A view of field photograph showing luxuriant growing of *Nepenthes khasiana* and *Gleichenia dichotoma* in West Khasi Hills, Meghalaya.

reconstruction is from 1790 to 2018 CE and its temporal browning (reduction) has a correlation with past droughts and famines. This first tree ring-based NDVI reconstruction from the western Himalayas and infers regional climate-vegetation dynamics during the past two centuries. This reconstruction provides valuable input for modelling vegetation dynamics for predicting vegetation changes due to climate variations in the western Himalaya.

In addition, another work on tree-rings stable isotope ($\delta^{18}\text{O}$ and $\delta^2\text{H}$), a 368 years long-term precipitation reconstruction of south-eastern Kashmir Himalaya was carried out. The reconstruction is characterised by stable wet conditions during the last phase of Little Ice Age, i.e. from 1682 to 1841 CE and drier conditions as compared to recent and historical period with intense pluvial events since 1850 CE.

Intra-annual density fluctuation (IADF) refers to anatomical changes in the tree rings caused by a sudden change in wood density in response to weather fluctuations. To reveal the occurrence of IADFs, the growth rings of Himalayan cedar (Fig. 7) growing over the Kullu region, Himachal Pradesh were analysed. The wood anatomy of growth rings revealed the frequent occurrences of IADFs in early and late woods. The Formation of IADFs in early wood (IADFe) is related to the reduced precipitation during the months of April to July, causing moisture stress in the soil. Inversely, wetter conditions in the late growing season, especially August-October, triggered the formation of IADFs in late wood (IADF_L). Analyses revealed several IADF years in early wood and late wood that revealed unusual climatic fluctuations which severely affected apple production, which is a major cash crop in this region.

A 463-year (1558-2021 CE) long tree-ring width chronology (TRWC) of *Cedrus deodara* (Deodar) from the Baspa Valley in Kinnaur region, western Himalayas

showed that spring and summer months' (February-March-April) moisture remains important for the growth of Deodar in the region. A 1643-2017 CE long spring-summer months drought reconstruction using standardised precipitation evapotranspiration index (SPEI04FMA) revealed a regional impact of westerly circulations over the western Himalayas in regulating moisture influx till mid 18th Century, cohering with Little Ice Age. Subsequent weakening of westerly circulations and strengthening of tropical oceanic circulations has been recorded due to tropical sea surface warming (Fig. 8).

The modern pollen study from Rukti and Sangla-Chitkul transects in the Baspa Valley, Kinnaur, Himachal Pradesh revealed incoherent pollen representation in relation to elevational distribution of plant taxa in the valley. Tree (arboreal) pollen distribution showed regional pattern due to long distance pollen transport by wind. Non-arboreal pollen taxa serve as good indicators of local ground vegetation and prevailing local environmental conditions. The autochthonous nature of pollen of *Juniperus* and *Rhododendron* tree taxa could be the indicators of relative tree-line shifts. Ongoing land-use activities mainly cultivation and fire burning were evident by the presence of pollen of various crops (Cerealia, Poaceae, Rosaceae, Polygonaceae, Amaranthaceae) and abundant microcharcoal particles respectively.

Multisource satellite and modelled data from 2000 to 2020 to investigate temporal and altitudinal variations in land surface temperature (LST) and air temperature with respect to surface albedo and cryosphere elements was carried out to understand elevation-dependent warming (EDW) in central Himalayas. According to our multi-temporal glacier inventory, the glacier area decreased from 2,710 km² in 2000-01 to 2,658 km² in 2020-21. Pro- and peri-glacial lakes have grown by 28% from 5.3 km² (165) in 2000 to 6.8 km² (209) in 2020, with a substantial rise of 36% in area and 32% in number above 4600 m asl, in line with glacier retreat (Fig. 9). The Moderate Resolution Imaging Spectroradiometer (MODIS) satellite-derived land surface temperature (LST) and ERA5-Land modelled near-surface air temperature showed a two-decade temperature trend, with a higher increase at higher altitudes. Over the past two decades, MODIS snow cover area and surface albedo have dropped, especially at higher elevations, along with temperature. These observations indicate EDW patterns and imprints, which are expected to increase due to the positive surface albedo feedback mechanism (Fig. 10).

PROJECT OUTCOME

Publications in SCI (Science Citation Index) Journals

1. Basumatary SK, Van Asperen EN, McDonald HG, Tripathi S & Gogoi R 2023. Pollen and non-pollen



Fig. 4 – The recovered non pollen palynomorphs (NPPs) from the Majuli section of Assam.

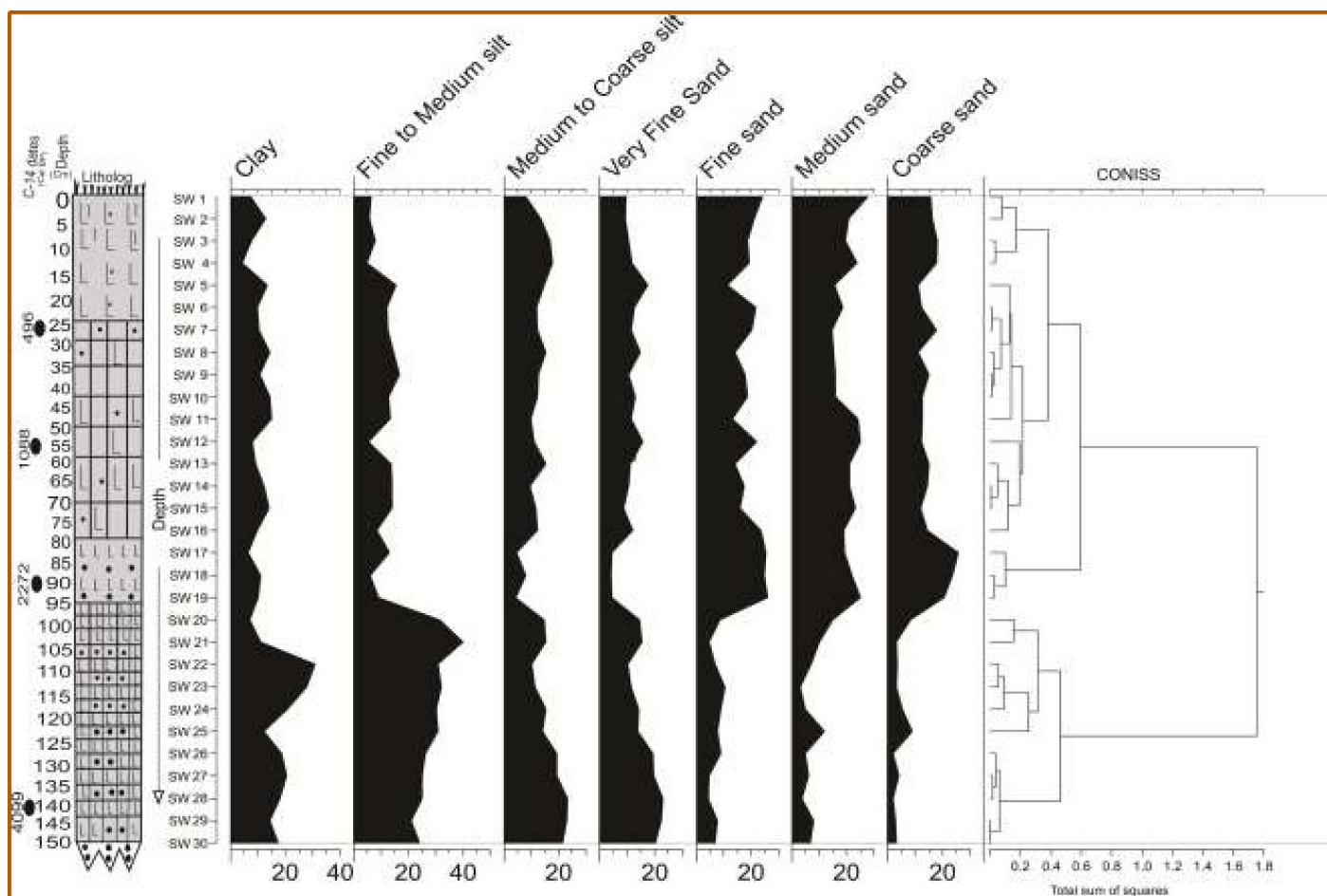


Fig. 5 - Granulometric analysis in sedimentary profile samples of Majuli Island, Assam.

palynomorph depositional patterns in Kaziranga National Park, India: Implications for palaeoecology and palaeoherbivory analysis. The Holocene 34(2): 224-238. DOI: 10.1177/09596836231211851 (IF-3.09).

2. Bhattacharyya A, Dhyani R, Joshi R, Shekhar M, Kuniyal JC, Ranhotra PS & Singh SP 2023. Is survival of Himalayan Cedar (*Cedrus deodara*) threatened? An evaluation based on predicted scenarios of its growth trend under future climate change. Science of the Total Environment 882: 163630. <http://dx.doi.org/10.1016/j.scitotenv.2023.163630> (IF - 9.8).
3. Chinthala BD, Ranhotra PS, Griebinger J, Singh CP & Brauning A 2023. Himalayan fir reveals moist phase during Little Ice Age in the Kashmir region of the western Himalayas. Quaternary Science Reviews 312: 108167. <http://doi.org/10.1016/j.quascirev.2023.108167> (IF - 4.16).
4. Dubey J, Ali SN, Quamar MF, Singh P, Morthekai P, Ghosh R, Sharma A & Srivastava V 2024. Vegetation diversity in response to monsoonal variability in the eastern Himalaya, India over the past~ 13 000 yrs. The Holocene, p.09596836241236355 (IF-3.09).
5. Jahan N, Rana YP, Singh RJ, Sathikumar R, Ali SN

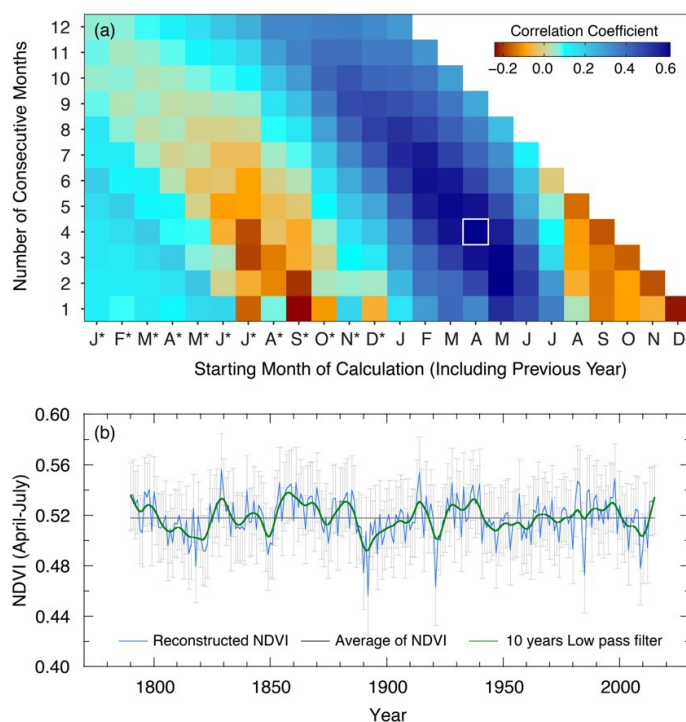


Fig. 6 - (a) Heatmap showing correlation between monthly regional NDVI and regional tree-ring chronology of *C. deodara* for 1983–2015 CE; (b) Reconstructed NDVI for mean April–July from 1790 to 2015 CE along with 10 years low-pass filter.



Fig.7 - Himalayan cedar tree.

- & Raza MA 2024. Morpho-structural signatures of neotectonic activity along the HFT bound Himalayan mountain front in Kathgodam-Chorgallia sector of NW Himalaya, India. *Quaternary Science Advances* 13: 100161 (IF: 4.5).
6. Maurya RS, Misra KG, Vishwakarma S, Singh V, Misra S & Yadava AK 2023. Analyses of intra-annual density fluctuation signals in Himalayan cedar trees from Himachal Pradesh, western Himalaya, India, and its relationship with apple production. *Frontiers in Forests and Global Change* 6: 1243352. doi:10.3389/ffgc.2023.1243352 (IF: 3.2).
 7. Pandey P, Ali SN, Bhardwaj A, Banerjee D, Khan MAR & Fulkar PG 2024. Pattern and imprints of

elevation-dependent warming on central Himalayan cryosphere as revealed by Earth Observation datasets. *Results in Earth Sciences*, <https://doi.org/10.1016/j.rines.2024.100021>.

8. Pandey P, Ali SN, Das SS & Khan MAR 2024. Rock glaciers of the semi-arid northwestern Himalayas: distribution, characteristics and hydrological significance. *Catena* 238: 107845 (IF: 6.2)
9. Pandey U, Nakatsuka T, Mehrotra N, Zhen L, Kato Y, Sano M & Shah SK 2023. Tree-rings stable isotope ($\delta^{18}\text{O}$ and $\delta^2\text{H}$) based 368 years long term precipitation reconstruction of South Eastern Kashmir Himalaya. *Science of the Total Environment* 892: 164640. <https://doi.org/10.1016/j.scitotenv.2023.164640> (IF: 9.8).
10. Singh AK, Shah SK, Pandey U, Deeksha, Thomte L, Rahman TW, Mehrotra N, Singh DS & Kotlia BS 2023. Vegetation Index (NDVI) reconstruction from western Himalaya through dendrochronological analysis of *Cedrus deodara*. *Theoretical and Applied Climatology* 115: 1713-1723. <https://doi.org/10.1007/s00704-023-04718-4> (IF: 3.4).
11. Tomar N, Roy I, Shri S, Chinthala BD, Shekhar M, Srivastava A, Ranhotra PS, Singh CP & Bhattacharyya A 2024. Modern pollen dispersal in relation to present vegetation distribution and land use in the Baspa Valley, Kinnaur, western Himalayas. *Environmental Monitoring and Assessment* 196: 194. <https://doi.org/10.1007/s10661-024-12340-8>. (IF: 3).
12. Tripathi S & Pandey A 2023. Palynological response deduced through spatially distinct surface samples to reconstruct palaeoecology and palaeoclimate of the Barak Valley, Assam (Indo-Burma region), northeast India. *Journal of the Palaeontological Society of India* 68(2): 154-172. DOI: 10.1177/05529360231205316 (IF: 0.65).

Book Chapters/Memoirs/Bulletins

1. Trivedi S, Srivastava A & Basumatary SK 2023. Pollen morphometrics of some taxa of family Malvaceae from Kanpur, Uttar Pradesh. In: National Conference on climate change & water security: Environment and health concerns.
2. Pandey U, Shah SK & Mehrotra N 2023. Fluctuations of Kolahoi Glacier, Kashmir Valley, its assessment with tree-rings of *Pinus wallichiana* and comparable satellite imageries and field survey records. In: Pandey M, Pandey PC, Ray Y, Arora A, Jawak SD & Shukla UK (Editors) - *Advances in remote sensing technology and the three poles*, John Wiley & Sons Ltd: 203-212. <https://doi.org/10.1002/9781119787754.ch13>.
3. Shekhar M, Singh A, David B, Tomar N, Roy I,

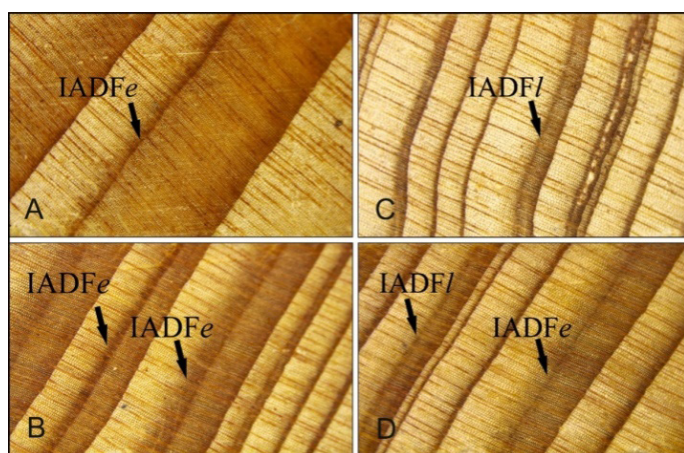


Fig. 8 - Images showing the Intra annual density fluctuations (IADFs).



Ranhotra PS & Bhattacharyya A 2023. The tree-ring-based drought and flood analyses from the Himalayan region: Limitations, challenges, and future perspectives. Book Chapter in Integrated Drought Management, Eds: Singh VP, Jhajharia D, Mirabbasi R, Kumar R. CRC Press, Taylor & Francis.

General Articles/Reports/Database Published

1. Mehrotra N & Shah SK 2023. Insight into the 4.2 ka event records in northeastern India: a global connection and the geological evidence. PAGES Newsletter 31(1): 28-29. <https://doi.org/10.22498/pages.31.1.28>.
2. पाण्डेय उत्तम, गाँधी नवीन, शाह संतोष कुमार एवं मेहरोला निवेदिता 2023. जलवायु परिवर्तन अनुसन्धान में वृक्षों का योगदान। इंद्रधनुष पत्रिका, अंक 21 पृष्ठ: 10-11.
3. त्रिपाठी स्वाति, ठाकुर बिस्वजीत, फर्तियाल बनिता एवं शर्मा अनुपम 2023. मध्य गंगा के मैदान में पुरा-पर्यावरणीय परिवर्तनों को समझने के लिए बहु-प्रॉक्सी आधुनिक एनालॉग की स्थापना. पुराविज्ञान स्मारिका अंक 2: 55-57. https://bsip.res.in/admin/assets/pdf-file/NTC_ENG_9933.pdf.
4. रविशंकर मौर्या, साधना विश्वकर्मा एवं कृष्ण गोपाल मिश्र 2023. पश्चिमी हिमालय: प्राचीन वृक्षों का प्राकृतिक आवास. पुराविज्ञान स्मारिका अंक (2): 22-27.
5. Newly developed modern analogue dataset based on biotic and abiotic proxy records could be accurate reference tool for the palaeo-ecological studies in the CGP. 2023. Science & Technology articles (DST-PIB release). <https://dst.gov.in/newly-developed-modern-analogue-dataset-based-biotic-and-abiotic-proxy-records-could-be-accurate>.
6. Can we forecast about climate change? Is it possible to save the plants, which are on verge of extinction? October, 2023. Hindi Vigyan Kosh. <https://open>.

substack.com/pub/hindivigyankosh/p/can-we-forecast-about-climate-change?r=lonipk&utm_campaign=post&utm_medium=web.

7. Phartiyal B, Tripathi S & Manoj MC 2023. XXI INQUA Congress 2023 Rome, Italy: India's successful bid to host the INQUA Congress in 2027. Journal of Palaeosciences 72(2): 175-178.

Publication other than the Project

1. Ali SN, Pandey P, Singh, P, Mishra S, Shekhar M, Misra KG & Morthekai P 2023. Intimidating evidences of climate change from the higher Himalaya: a case study from Lahaul, Himachal Pradesh, India. Journal of the Indian Society of Remote Sensing 51(5): 1099-1112 (IF: 2.5).
2. Babushkina EA, Zhirnova DF, Belokopytova LV, Mehrotra N, Dergunov DR, Shah SK & Veganov EA 2023. Conifer quantitative wood anatomy as proxy data: application in agricultural yield reconstruction. Trees. <https://doi.org/10.1007/s00468-023-02437-x> (IF: 2.3).
3. Mehrotra N, Basavaiah N & Shah SK 2023. Revisit the Medieval Warm Period and Little Ice Age in proxy records from Zemu Glacier sediments, Eastern Himalaya: Vegetation and climate reconstruction. Quaternary 6(2): 32 <https://doi.org/10.3390/quat6020032>. (IF: 2.3).

SPONSORED PROJECTS (SP) & COLLABORATIVE PROJECTS (CP)

SP 6.1: Holocene palaeovegetation and climate changes in relation to the palaeoflood

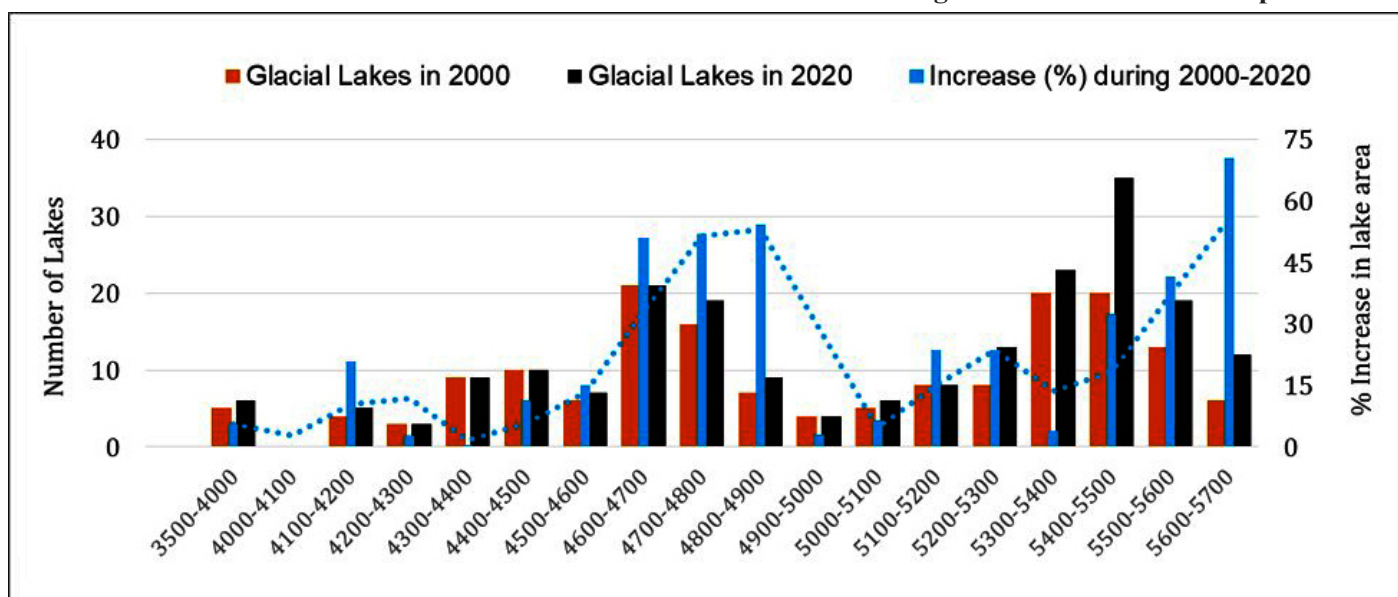


Fig. 9 - The bar plot graph for comparison of the number of glacial lakes and the percentage change in the area (expansion) of the glacial lakes between 2000/01 and 2020/21 at every 500 m elevation zones of the study area.

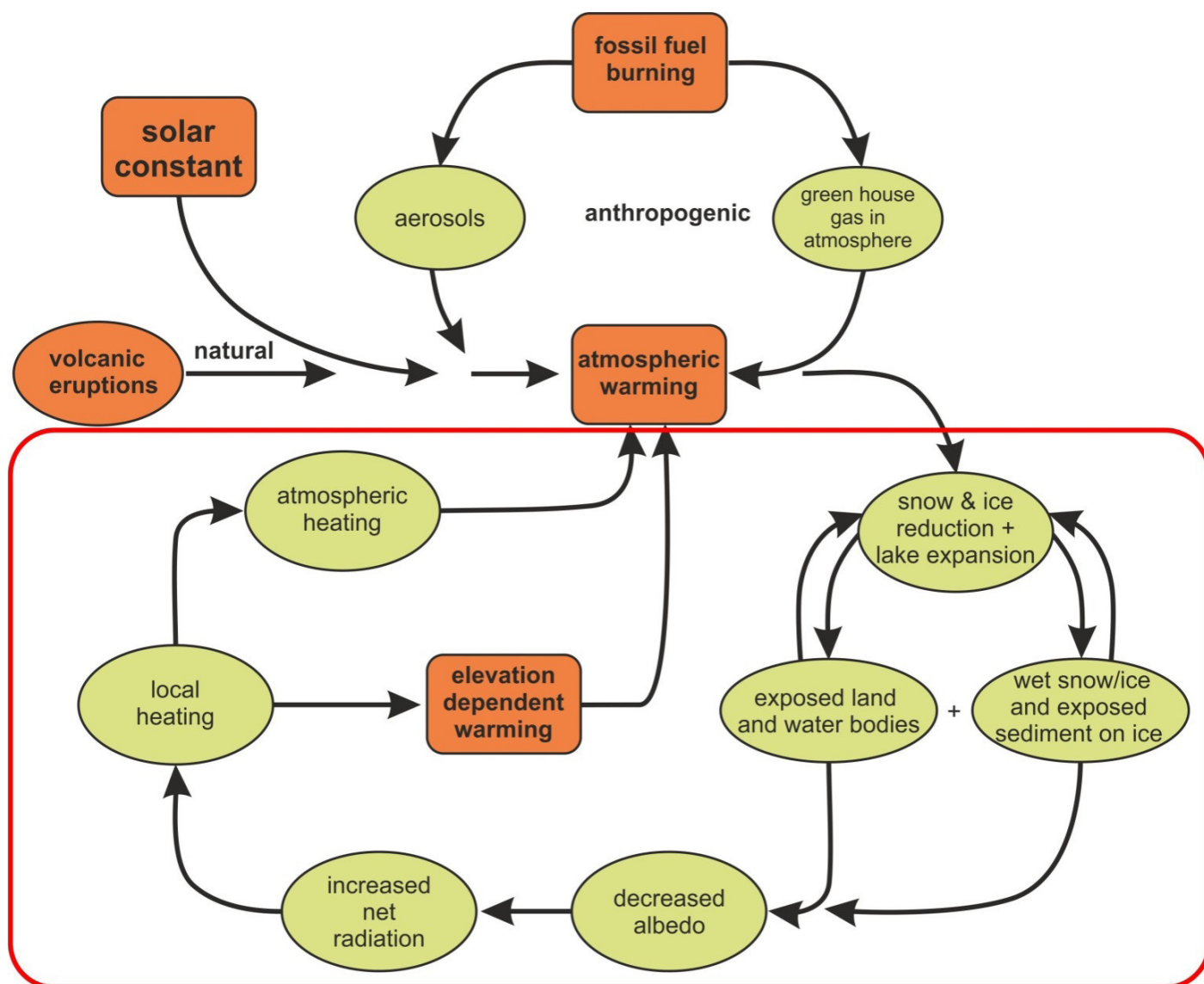


Fig. 10 - Schematic of climate feedbacks showing connections of positive glacier ice/glacial lake/snow albedo feedback. The bottom panel within the red rectangle shows the processes addressed in this research for the central Himalaya.

episodes in central Brahmaputra Valley of Assam, India based on multiproxy analysis [Sponsored by SERB-DST; Project No. SERB-DST-EEQ-2021/000846, w.e.f. 10.03.2022).

Investigators: Sadhan K Basumatary (PI) and Siddhant Vaish (JRF)

Palynological analysis of 75 surface soil samples collected from the forestland, swamp and grassland in the Pobitora Wildlife Sanctuary of Assam. Study observed that, in the forestland, the pollen data accurately match with the extant forest composed of *Lagerstroemia*, *Syzygium*, *Albizia* and *Barringtonia*. The pollen data from the swamp is characterised by the dominance of the marshy and aquatic taxa composing of *Polygonum*, Onagraceae, Cyperaceae, *Potamogeton*, *Lemna*, *Nymphaea*, and *Eichhornia* which are indicative of the perennial water-logged condition in



Fig. SP 6.1 -View of Rhinoceros unicornis grazing in Pobitora Wildlife Sanctuary, Assam.



Fig. SP 6.2 - Collection of tree-ring samples, Field visit team and sample processing.

response to the high monsoonal activity in the region. In the grassland, the grass pollen is dominant at the value of 50% in the pollen assemblage. The presence of high land entemophilous taxa namely *Rhododendron* in the pollen assemblage is indicative of the flood activity in the region (Manuscript submitted).

SP 6.2: Response of forest ecosystem to climate change in the Karnali region of Nepal Himalaya [Sponsored by Tribhuvan University, Nepal under Excellent Research Grant, Project No. TU_079/080_ERG-12, In progress].

Investigators: Santosh Kumar Shah (BSIP Lucknow) [& Narayan Prasad Gaire (PI), Binod Baniya, Bidur Nepal, Raju Chauhan (Tribhuvan University, Nepal)]

Field visit was carried out from October 25 to November 8, 2023 in the Jumla and Mugu districts of Karnali Province, Nepal. More than 500 tree-core samples were collected from various conifer and broad-leaved taxa growing in different forest localities. Laboratory processing of the samples at Patan Multiple Campus, Tribhuvan University has been completed (Fig. SP 6.2). Literature review, acquiring of geo-spatial data and cross-dating of the samples are in progress.

SP 6.3: Investigation of xylogenes from alpine and high altitude Himalayas to analyse climate change and its consequences on extreme ecological environments (Sponsored by SERB-DST, Project No. SCP/2022/000706, w.e.f. 15.03.2023).

Investigator: K.G. Misra

The Himalayan birch (*Betula utilis*) is a broad-leaved deciduous tree that typically thrives near the treeline in the high elevations of the Himalayas. Samples in the form of increment cores have been collected from adjoining areas of Thundabhuji (~3500 masl), Kullu, Himachal Pradesh. Using Himalayan birch samples 445-year-long ring-width chronology has been developed. The tree-growth-climate relationship shows that precipitation has a direct relation with tree growth throughout the year except for the previous year's October-November and the current year's April to June. However, winter precipitation (January-March) plays a significant role in the tree's radial growth from the study site, enabling the development of precipitation reconstruction. In contrast, temperature has an inverse relation with tree growth throughout the year except for the months of January, July, and August.

SP 6.4: **Modelling and mapping of forest age distribution in the Alpine Himalayan region using dendrochronology and remote-sensing approach** (Sponsored by SAC-ISRO, Ahmedabad. Project No. SAC/EPSA/BPSG/ALPINE/SHRESTI/ 09/2019; w.e.f. May 2019 till 31st March 2024).

Investigators: Parminder Singh Ranhotra (PI) and Nidhi Tomar (SRF)

Investigated the stand structure (age, girth and height), tree-line dynamics and tree-growth-climate relationship of *Betula utilis* (Birch) from the Gulmarg Valley, Kashmir, J & K, western Himalaya. Average shift rate of Birch along the ~3173-3522 masl transect was calculated ~0.86 m/year. Presently the studied transect is dominated by the Birch trees with ~80% population of young Birch population (<100 years), over the moisture tolerant *Abies pindrow* (Fir) trees. The clearance of older Birch trees from the area by local population for fire burning could probably be the reason for dominance of young Birch trees.

CP 6.1: **Sadhan K. Basumatary** [& Alka Srivastava; Sneh Trivedi (Department of Botany, DG College, Kanpur).

Palynological analysis of 30 honey samples collected from Kanpur and its neighboring areas. Study reveals that the pollen data generated from the honey samples could be a reliable baseline for the palaeovegetation and climate interpretation in and around the study region.

CP 6.2: **Swati Tripathi, Arya Pandey, Anjum Farooqui, Priyanka Singh, Firoze Quamar & Rajiv Ranjan** [& Arti Garg; A.N. Shukla (BSI, Allahabad)].

The pollen morphology of fifteen popular arboreal taxa of the family Fabaceae and subfamily Caesalpinioideae comprising eight species of *Bauhinia* including one natural hybrid, *B. xblakeana* Dunn., two species of *Cassia*, three species of *Senna* and two species of *Caesalpinia* growing in the Indo-Gangetic plain of central India were examined using Light Microscope (LM) and Field Emission Scanning Electron Microscope (FESEM) for the taxonomic characterisation, palaeoecological, implications and correlation with other species growing around the world. Our study also reports the pollen morphometry of *Caesalpinia peltophoroides* Benth., *Caesalpinia ferrea* Mart. ex Tul., and spontaneous hybrid of *Bauhinia* (*B. xblakeana*) for the very first time (Revised MS submitted to Botany Letters).

CP 6.3: **Swati Tripathi & Arya Pandey** [& A.K. Shukla; Brijesh Kumar and & Arti Garg (BSI, Allahabad)].

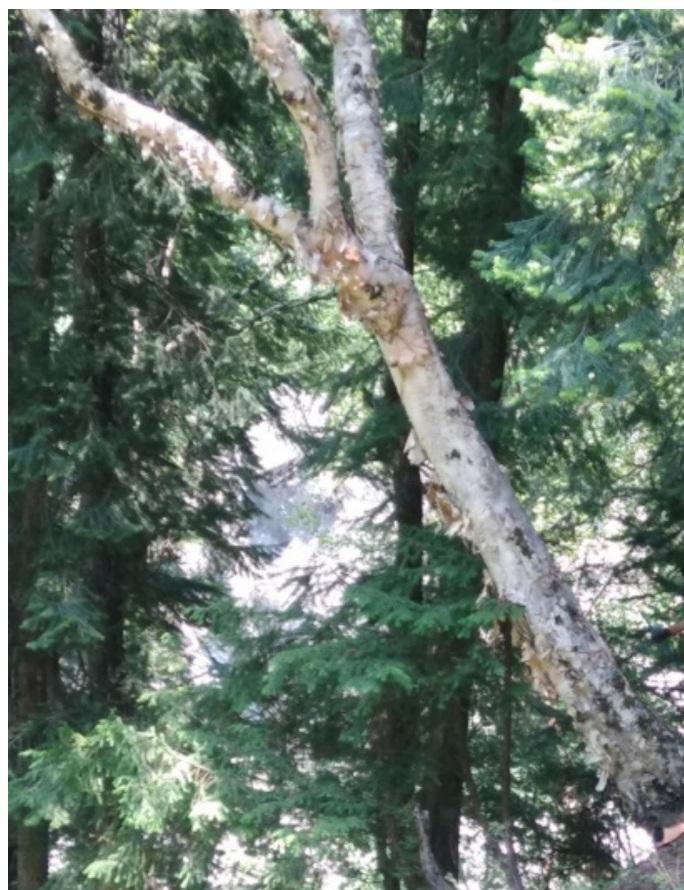


Fig. SP 6.3 - Himalayan birch growing with other conifer species.

The detailed investigation of spore morphology of 21 species of genus *Adiantum* (commonly known as “Maiden Hair Fern”) growing in tropical and subtropical regions of the world has been studied using LM and FESEM. The generated database would highlight the taxonomic characterisation of these species with finer morphometrical variations that would be useful to correlate the studied species with other *Adiantum* species growing around the world. The study of their spore variability would provide an aid for understanding their adapting characters towards the changing climate and also reflect the environmental implications of the respective area where these species are growing (MS under preparation).

CP 6.4: **Swati Tripathi** [& Arti Garg BSI, Allahabad].

The dung of the Indian Bear (*Melursus ursinus*) was analysed using biotic and abiotic proxies to determine its dietary habits in relation to the plant diversity and ecology in the tropical dry deciduous forest of the Kuno National Park, Madhya Pradesh. The continuous recovery of arboreal pollen taxa, chiefly *Anogeissus*, *Boswellia*, *Butea*, *Madhuca* and Fabaceae display the existing vegetation and climate in the region.

CP 6.5: **S.K. Basumatary, Swati Tripathi & Anupam Sharma** [& Indian Institute of Geomagnetism, Mumbai].

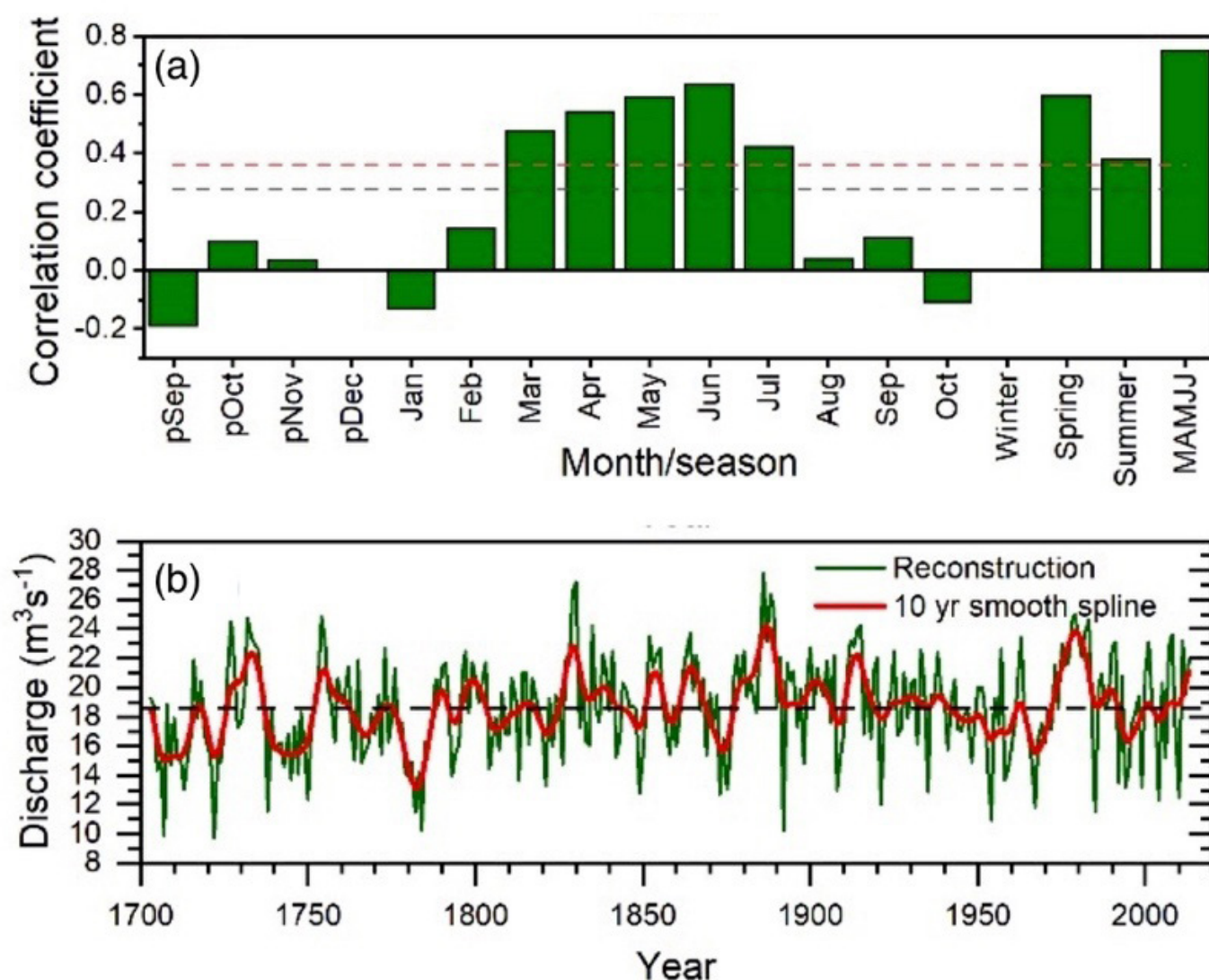


Fig. CP 6.7 - (a) Pearson's correlation coefficient between the composite tree-ring standard chronologies and monthly and seasonal stream flow data (b) March-July average streamflow reconstruction of Sinja River, Karnali Basin.

Palynological examination of 760 cm deep Parad sedimentary section along the left bank of the Purna River of Akola District, Maharashtra indicates the occurrence of tropical dry deciduous forest between 3465 to 1650 cal. yrs. BP. For the last 200 cal. yrs. BP, the striking increase of cultural pollen taxa suggests the enhanced anthropogenic activities in and around the region.

CP 6.6: Swati Tripathi [& Arti Garg, (BSI, Allahabad)].

The detailed pollen morphometrical estimation of 30 pollen taxa belonging to grass family (Poaceae) was carried out with the help of LM and FESEM analysis for the taxonomic characterisation and palaeoecological implications and moreover, to distinguish them into cereal ($>45\mu\text{m}$) and non-cereal ($<45\mu\text{m}$) pollen for the reconstruction of agricultural practices during the Holocene epoch. Some of the studied species are as follows-wild grass (*Cynodon*, *Setaria*, *Themeda*, *Digitaria*) and cereals (*Sorghum*, *Zea mays*, *Oryza*, *Triticum*, etc.).

CP 6.7: SK Shah [& Narayan P. Gaire, (Tribhuvan University, Nepal)].

A robust reconstruction model was developed between tree growth and streamflow, capturing 56% of the variance in the actual data, and used to reconstruct the March-July month average streamflow of Sinja River, Karnali Basin, Nepal. The reconstruction is extended from 1700 to 2013 CE and revealed several dry and pluvial periods with the recent decline in the streamflow (Fig. CP 6.7).

CP 6.8: SK Shah [& Babushkina E. and Team (Khakass Technical Institute, Siberian Federal University, Abakan, Russia)].

Tree-ring wood anatomy records (Fig. CP 6.8) from Russia was used towards the reconstruction of crop yield. This pioneering study tests cell-scale quantitative wood anatomy (QWA) of conifer tree species as a proxy for crop yield in the moisture-limited plains of Khakassia (South Siberia). The reconstructed history of the low-yield years

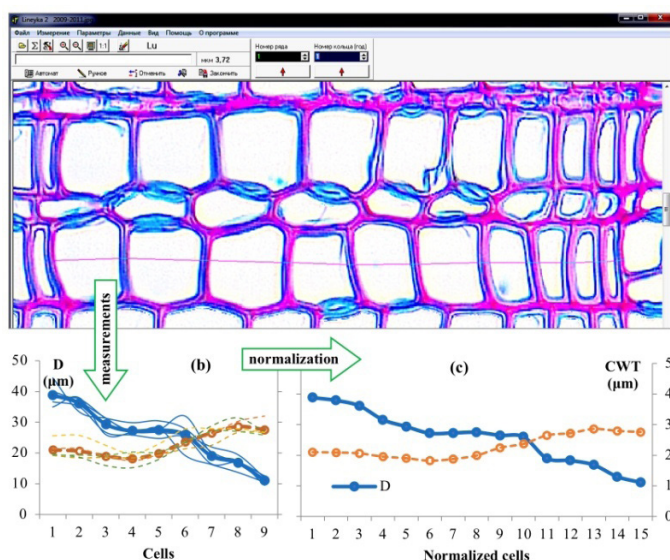


Fig. CP 6.8 - Measurements and initial processing of anatomical parameters of tree-rings.

is supported by documented evidence of crop failures, droughts and other related events.

CP 6.9: SK Shah [& Nivedita Mehrotra (BSIP)]

Quantitative climate reconstruction for Mean annual precipitation (MAP) and Mean temperature of warmest month (MTWA) for the last 2992 cal years BP (1042 BC) was developed from North Sikkim using fossil pollen records from Yabuk, Zemu Glacier (Fig CP 6.9). The variability observed in the reconstructions was analyzed for global past climatic events. The reconstructions captured comparable Medieval Warm Period (MWP) and Little Ice Age (LIA) like events from the Zemu Glacier region.

OTHER ACADEMIC WORKS

Research Papers Presented

1. Trivedi S, Srivastava A & Basumatary SK 2023 - Melissopalynological analysis and its implication on sustainable development. National Conference on current trends in biological sciences for sustainable agriculture, environment and health under climate change & XV Convention of the Indian Society of agricultural biochemists, 23th-25th November, 2023 at Department of Botany, University of Lucknow, Lucknow (Abstract: 101).
2. Vaish S, Basumatary SK & Arya AK 2023 - Preservation of fungal spore in relation to the different vegetation types in Pobitora Wildlife Sanctuary: Implication to palaeoecology and palaeoherbivory analysis. International Conference on climate change and Geosciences, 5th & 6th February, 2024

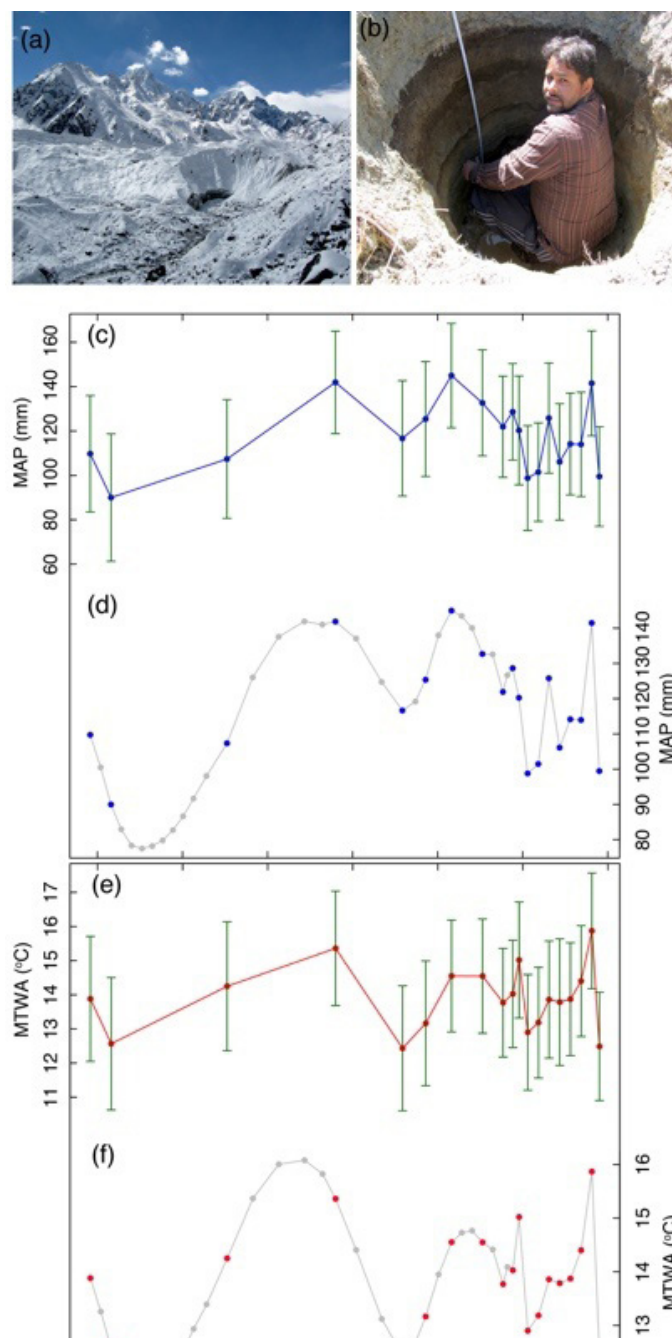


Fig. CP 6.9 - (a) Snout of Zemu Glacier, (b) Sub-surface sample collection, reconstructed climates (c) MAP and (e) MTWA since 2992 cal years BP (1042 BC). The grey dots in (d) and (f) are interpolated values where the palynomorphs not recovered.

at Department of Geology, Bangalore University (Abstract:123).

3. Shah SK, Mehrotra N, Thomte L, Pandey U & Gaire NP 2023 – Interface of tree-ring $\delta^{18}\text{O}$ spectrum across moisture regime of south-eastern Tibetan Plateau. XXI Congress of the International Union for Quaternary Research (XXI INQUA-2023). Italy, Rome, July 13-20, 2023.
4. Mehrotra N, Shah SK, Malsawmliana M & Kar R 2023 – Holocene climatic and vegetation changes recorded in the Late Holocene sediments from Twai



Wild Life Sanctuary, Mizoram, north-east India. XXI Congress of the International Union for Quaternary Research (XXI INQUA-2023). Italy, Rome, July 13-20, 2023.

5. Misra KG, Singh V, Singh AD & Yadav RR 2023 - Tree-ring deduced four century-long drought records from Jammu & Kashmir, north-western Himalaya, India. American Geophysical Union (AGU) 2023, held online in San Francisco, CA, USA, January 22-25, 2024.
6. Tripathi S, Basumatary SK, Singh H, McDonald HG & Pokharia AK 2023 - Multiproxy analysis of endangered Yak (*Bosmutus*) dung from Indian Himalaya: Implications for palaeoecology and palaeoherbivory. 21st INQUA Congress, Sapienza University, Rome, Italy, July 13-20, 2023 (Session: 109).
7. Tripathi S, Pandey A, Basumatary SK, Khan S & Thakur B 2023 - Climate induced vegetation alterations in Majuli Island (world largest river island) of northeast India for the last 4100 cal. BP: an interpretation based on modern pollen calibrations. 21st INQUA Congress, Sapienza University, Rome, Italy, July 13-20, 2023 (Session: 98).
8. Pandey A, Tripathi S, Thakur B & Singh H 2024 - Climate-induced vegetation alterations during early-mid Holocene in Garamur wetland of Majuli Island (the world's largest river island) northeast India: an interpretation based on multiproxy records. Shodh Sangam, Institute of Science, Banaras Hindu University, February 21-23, 2024 (Abstract 18).
9. Ranhotra PS, Jain S, Shekhar M & Tomar N 2023- Holocene climate anomalies and impact on vegetation dynamics in the Himalayan region. Young Scientists' online meeting on climatic change and earth systems Organized by Nepal Academy of Science & Technology, Nepal in association with TWAS Central & South Asia Regional Partner (TWAS-CASAREP) Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru, India (01-03 November 2023), at Kathmandu, Nepal.
10. Ranhotra PS, Roy I, Tomar N, Navya R, Krishnamurthy A, Prasad S, Florence Mazier & Marie-José Gaillard 2023 - Regional estimates of vegetation abundance inferred land-use changes in western Himalayas during Late Holocene XXI INQUA 2023 Jul 2023 Rome (Italie), Italy [hal-04228180].
11. Roy I, Ranhotra PS, Tomar N, Gandhi N, Shekhar M, Bhattacharyya A, Baghel P & Sharma R 2023 - Reconstruction of tree-line shifts during Late Pleistocene - Holocene time in the summer monsoon dominated region of western Himalaya, at the XXI

INQUA Congress-2023 organized at Sapienza University, Rome, Italy.

Deputation to Conferences/Seminars/Workshops (both online and offline)

SK Shah

- Participated in XXI Congress of the International Union for Quaternary Research (XXI INQUA-2023), Italy, Rome, July 13-20, 2023.

KG Misra

- Participated in the AGU 2023 organized by the American Geophysical Union in San Francisco, CA, USA, held online on 22-25 January 2024.
- Attended workshop on "An introduction to crest, an R package to perform probabilistic climate reconstruction from palaeoecological datasets", Rome, Italy, July 16, 2023.

Swati Tripathi

- Participated in the 21st INQUA Congress, Sapienza University, Rome, Italy during July 13-20, 2023.

PS Ranhotra

- Young Scientists' online meeting on climatic change and earth systems organized by Nepal Academy of Science & Technology, Nepal in association with TWAS Central & South Asia Regional Partner (TWAS-CASAREP) Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru, India (01-03 November 2023), at Kathmandu, Nepal.

Training/Study Visits

SK Shah

- Supervised M.Sc. Dissertation of Ms. Asmaul Husna, TU Dresden, University of Copenhagen, Denmark on the topic "Multispecies tree-ring based streamflow reconstruction in Parvati Valley, western Himalaya"
- Supervising M.Sc. Dissertation of Mr. Basunandan Handique, Babasaheb Bhimrao Ambedkar University, Lucknow (in progress).

KG Misra

- Organized a two-day CBSE Principals training from 14-15 December 2023 at BSIP, Lucknow.



Swati Tripathi

- Training imparted to Mr. Yasir Jamal (M.Sc. Geology; Aligarh Muslim University, Aligarh) on topic entitled 'Palynological response deduced through spatially distinct surface samples to reconstruct palaeoecology

PH.D. PROGRAMMES

	Naushi Aneez (2017). A study on geoenvironmental status of Kukrail Reserve Forest, Lucknow, Uttar Pradesh with special reference to its soil properties, under the supervision of Swati Tripathi (BSIP) and Ajay Kumar Arya (Lucknow University), registered with Department of Geology, Lucknow University. Status: Submitted (July, 2022).
	Kajal Singh (2018). Study of the Late Pliocene-Holocene climatic and environmental changes around Ny-Alesund, Svalbard, under the supervision of Ratan Kar (BSIP) and Ashwani Raju (BHU), registered with Banaras Hindu University, Varanasi. Status: In-progress.
	Deeksha (2021). Tree-ring analysis of teak from central India, under the supervision of Santosh K. Shah (BSIP) and Munendra Singh, (Lucknow University), registered with Lucknow University, Lucknow. Status: In-progress.
	Korobi Saikia (2020). Holocene climate variability and its impact on the C3/C4 plant communities in the western margin of the Bengal Basin: phytolith based evidences, under the supervision of Shailesh Agrawal (BSIP) and Subir Bera, C.U., Angela A. Bruch, Senckenberg Research Institute, Germany, registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Ravi Shankar Maurya (2020). Tree-ring based climate reconstruction from Himachal Pradesh, western Himalaya and its association with glacial dynamics, under the supervision of K.G. Misra (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Sadhana Vishwakarma (2020). Development of multi-century long climate records using tree-rings from Uttarakhand, India, under the supervision of K.G. Misra (BSIP) & Prof. Nandita Ghosal, BHU, registered with Banaras Hindu University, Varanasi. Status: In-progress. **
	Nidhi Tomar (2021). Late Quaternary vegetation and hydroclimatic variabilities in the Himachal region of western Himalaya, under the supervision of Parminder Singh Ranhotra (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Arya Pandey (2020). Climate-induced Holocene vegetation response and anthropogenic impact in upper Brahmaputra Valley of Assam, northeast India: signatures of global climatic events, under the supervision of Swati Tripathi (BSIP) and Hema Singh (BHU), registered with Department of Botany, Banaras Hindu University. Status: In-progress.
	Prachita Arora (2020). Timing, extent, and sensitivity of the glaciers to the Late Quaternary climate variability in the Higher Sikkim Himalaya, under the supervision of S. Nawaz Ali (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Pushpendra Pandey (2022). Analyzing the extreme climatic events in the western Himalaya using tree-rings, under the supervision of PS Ranhotra (BSIP) , Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Siddhant Vaish (2022). Holocene climate changes based on geobiological proxies and geomorphological investigations in parts of central Brahmaputra Valley of Assam, India, under the supervision of Sadhan K. Basumatary (BSIP) and Ajay Kumar Arya (Lucknow University, Lucknow). Status: In Progress.
	Tanveer W Rahman (2022). Evaluation of climatic indices and past climate reconstruction using tree-rings of <i>Abies</i> spp. from the Himalaya region, under the supervision of Santosh K. Shah (BSIP) and Anup Saikia, Geography Department, Gauhati University, Assam. Status: In-progress.
	Yubraj Dhakal (2023). Response of forests of Karnali region to climate change in the Nepal Himalaya using tree rings of multi-tree taxa, under the supervision of Dr. SK Shah (BSIP) and Prof. Narayan P. Gaire, Department of Environmental Science, Patan Multiple Campus, Tribhuvan University, Lalitpur, Nepal). Registered with Tribhuvan University, Lalitpur, Nepal. Status: In-Progress (Candidate works at Tribhuvan University).



	Mitra Rajak (2024). Investigating the glacier dynamics and climate change induced glacial hazards in the Indian central Himalaya, under the supervision of Dr. S. Nawaz Ali (BSIP) registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Shubhajit Ghosh (2024). Spatiotemporal distribution of forest fire and their impact on central Himalayan cryosphere, under the supervision of Dr. S. Nawaz Ali (BSIP) registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.

and palaeoclimate of the Barak Valley, Assam, northeast India' under 'Summer Research Fellowship Programme' of Indian Academy of Sciences, Bangalore (June-August, 2023) (Research Report submitted).

Lectures delivered

Ratan Kar

- Delivered series of ten lectures in 'Geoarchaeology' for students of Post Graduate Diploma in Archaeology at Institute of Archaeology (ASI), Noida, January 5-7, 2024.

SK Shah

- लखनऊ के बी.सा.पु.सं. की तिमाही हिन्दी कार्यशाला में जलवायु परिवर्तन अनुसंधान में वृक्षवलय (ट्री-रिंग) का योगदान विषय पर 20 मार्च 2024 को हिन्दी में आमंत्रित व्याख्यान दिया।
- Delivered Course work talks for AcSIR enrolled Ph.D. scholar of BSIP, Lucknow on (i) Scientific Methods, Design of experiment / research work process and its implementation and (ii) various talks on Dendrochronology (as per schedule given by AcSIR Coordinator, BSIP).

Swati Tripathi

- Delivered an invited lecture entitled 'Climatic induced vegetation alterations during Rapid climatic events in northeast India: biotic assessment from the Barak Valley of Assam', Department of Applied Geology, Dibrugarh University, Assam (February 5, 2024).
- Delivered a lecture entitled 'Writing of an abstract for scientific community and common men', AcSIR Ph.D. program, BSIP, Lucknow (on September 22, 2023).

ACCOLADES RECEIVED

Swati Tripathi

- Research article pertinent to the modern analogue studies in the Central Ganga Plain (published in journal 'Catena' in 2023) was included in the DST newsletter for the Public Information Bureau (PIB) with the title 'Newly developed modern analogue dataset based on biotic and abiotic proxy records could be accurate reference tool for the palaeo-ecological studies in the

CGP' (placed under S & T articles on the DST website. <https://dst.gov.in/newly-developed-modern-analogue-dataset-based-biotic-and-abiotic-proxy-records-could-be-accurate>.

- Member of the BSIP Bidding team to present bid at the 21st INQUA congress, Rome, Italy 22nd INQUA Bid winning by the India for the year 2027.

REPRESENTATION IN COMMITTEES/BOARD

Ratan Kar

- Member, State Level Expert Appraisal Committee (SEAC), Ministry of Environment, Forest and Climate Change.

Sadhan K. Basumatary

- Member, Editorial Board, Bio-Science Letters (an e journal of Bodoland University, Assam, India).
- Member -Editorial Board, Journal of Geophytology

SK Shah

- Associate Editor, Dendrochronologia (since October, 2023)
- Guest Associate Editor, Frontiers in Earth Science (since, 2016)
- Treasurer, Association of Quaternary Researchers (AOQR) for 2019-2024
- Reviewer of manuscript submitted in journals - Dendrochronologia, Climate Dynamics, Forests, and Quaternary.
- Member AcSIR Academic Committee.

PS Ranthotra

- Editor - Journal 'Geophytology' (The Palaeobotanical Society, India)

Swati Tripathi

- संयोजक एवं सदस्य, हिंदी राजभाषा कार्यान्वयन समिति, बी.सा.पु.सं
- संपादक, 'पुराविज्ञान स्मारिका' (अंक 2023), संस्थान की राजभाषा पत्रिका
- Convener, Media & Press Release Committee, BSIP, Lucknow
- Assistant Editor, Journal of Palaeosciences

Project 7: Reconstructing Human-Environment Interactions, Agricultural Strategies and Archaeo-Chemical imprints using Macrobotanical, Geochemical, Isotopes and Ancient DNA (aDNA).

COORDINATOR: ANIL K POKHARIA (SCIENTIST F)

OBJECTIVES

- To understand the early agricultural management, and cropping strategies/intensity during Prehistoric and Historic times.
- Characterise the paradigm-shift/transitions in lifestyles, with adoption of farming, and emergence of new technologies such as metal-working (Chalcolithic) and writing (Early Historic onwards).
- To assess impact(s) of geological climatic episodes (e.g. 4.2ka BP, the initiation of Meghalayan Era, MWP (~900-1450 AD), LIA (~1500-1850 AD), MW (1850 AD onwards) on human habitations.
- To understand the past population dynamics, domestication strategies and adaptation of human population using state of the art ancient and modern genomics.

PREAMBLE

The first component deals with macrobotanical remains from Jogna-Khera (Lat. 29°52' N; Long. 76°26' E), Bara culture site contemporary to Late Harappan in semi-arid tropics of the north-western India of the subcontinent for reconstructing subsistence model during 1700-1400 BC. The ancient settlement on the bank of palaeochannel of Vedic Saraswati (?), is of archaeological importance and was excavated, under the momentous Saraswati Heritage Project of National importance. The site has revealed Bara cultural deposit measuring about 5.50 m in thickness and divisible into 14 distinct strata or layers. Recorded from Bara in Punjab for the first time, this culture of peasantry community is akin to Harappan Civilization and regarded to have supplied the economic basis for cities in the form of agricultural surplus. But for slight difference in ceramics, for all practical purpose the information on ancient crop remains would provide the inference to reconstruct the economy of Harappans.

The second component deals with Paleogenomics or ancient DNA analysis to understand demographic history of South Asia. Genomic data and archaeological records are the key components to understand past population dynamics, migrations and mixing events. New genetic data from the various sites, e.g. Ladakh, Vadnagar (Gujarat), Pattanam (Kerala) and Sri Lanka added up significant information in the existing genetic literature of South Asia.

PERSONNEL INVOLVED

Team Member: Niraj Rai (Scientist D)

Technical Support: Nandita Tiwari (Technical Officer A)

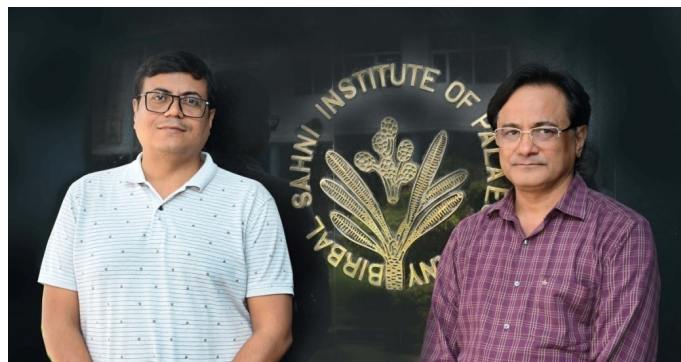
SIGNIFICANT FINDINGS

Archaeobotany:

To reconstruct the model of ancient agriculture in region of Kurukshetra during 1700-1400 BC, the site is of considerable importance. Huge heaps of soil from cultural deposits ranging from layer 1 to 14 were kept for water floatation by the excavators. Out of 14 layers, soil from layers 5 to 12 revealed crop remains and other wild seeds and fruits. Charred grains, seeds and fruits have been found mixed with small bits of wood charcoal. The organic remains furnish the evidence of the rotation of crops (Fig. 1). Interesting is that the cultivation of rice, the native crop of Ganga Valley, is apparent by the carbonized kernels and the copious mixture of rice-husk used as degraissant in the pottery.

Archaeogenomics

Under the research theme of Archaeogenomics, we are using cutting edge research based on ancient DNA extraction and whole genome sequencing analysis to understand pre-historical population structure and demographic changes in South Asia. Under this research umbrella we have built up strong archaeological networks coupled with an institutional network of domestic labs and analysis capacity. By focusing on ancient genomics as a methodological approach, we are leading research into the origins and relationships of humans, animals and pathogens in the region. By working with archaeologists and archaeological scientists we are revealing an integrated



(L to R): Niraj Rai & Anil K. Pokharia

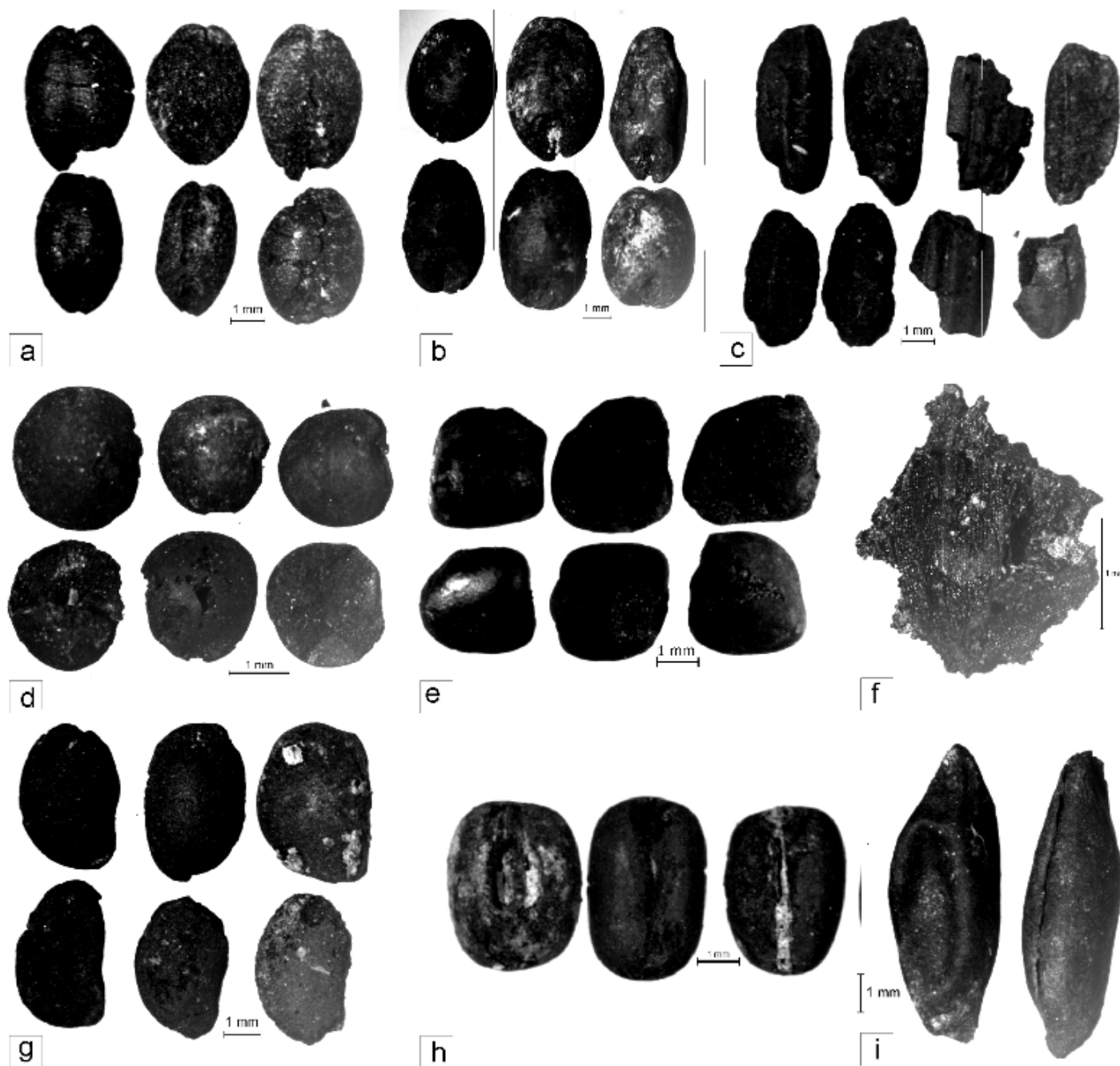


Fig. 1 – Plant remains recorded from Jogna-Khera archaeological site, Kurukshetra, Haryana: a. *Hordeum vulgare* (barley); b. *Triticum aestivum* (bread-wheat); c. *Oryza sativa* (rice); d. *Lens culinaris* (lentil); e. *Lathyrus sativus* (grass-pea); f. Congealed mass of rice husk; g. *Macrotyloma uniflorum* (horse-gram); h. *Vigna radiata* (green gram); i. Cucurbitaceae seeds (*Cucumis* sp. ?)

and pioneering understanding of the human past, as well as changing environments and disease. Working on some very interesting historical context, we have successfully completed following projects-

The Maternal Genetic Origin and Diversity of the Extant Populations of the Ladakh Region in India:

For the first time we have generated and published genetic data of 108 unrelated individuals from Ladakh belonging to three population groups namely, Changpa (n=38), Brokpa (n=32) and Monpa (n=38). We reported that maternal ancestry of the three Ladakhi groups are highly diverse

carrying lineages specific to Tibet (A21) and South Asia (M3, M30, U2) (Fig. 2). In our analysis we found that Changpa and Monpa tribes share maternal ancestry compared to Brokpa, which is very distinct and also later suffered possible historical bottleneck. We also observed that maternal lineage of Changpa and Monpa communities of modern day Ladakh share some genetic history with Tibeto-Burman speakers in past. These findings conclusively indicate possible matrilineal genetic inflow in Ladakh from three directions, primarily from Tibet and South East Asia during post-glacial, West Eurasia and also from South Asia.

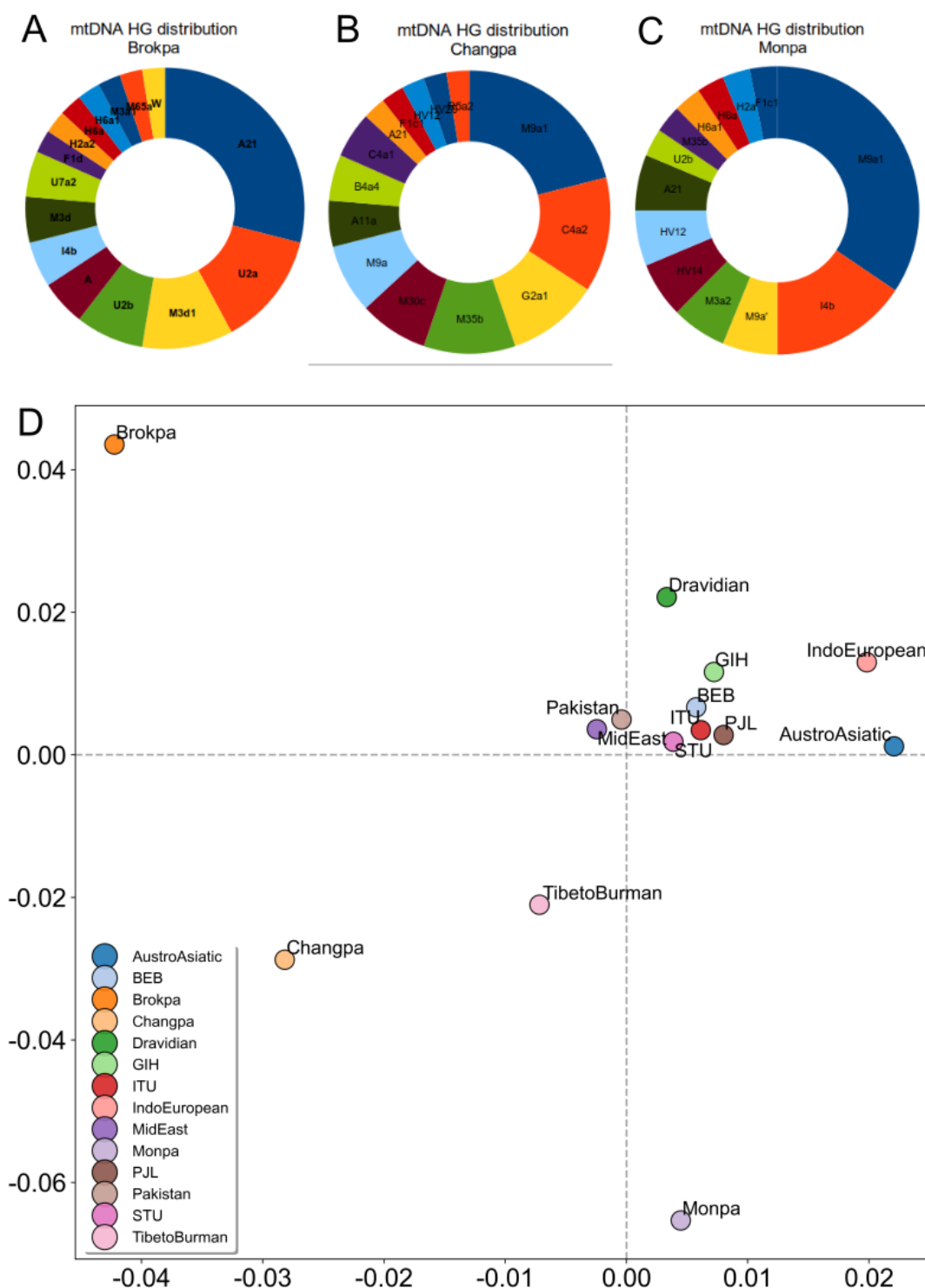


Fig. 2 - Mitochondrial DNA haplo group frequency within three studied population of Laddak.

Reconstructing the population history of the Sinhalese, the major ethnic group in Sri Lanka: For the first time we have generated genome wide genetic data of Sinhalese population of Sri Lanka who are also an ethnic group inhabiting nearly the whole length and breadth of the island. We have performed a high-resolution fine-grained genetic study of the Sinhalese population and, in the broader context, we attempted to reconstruct the genetic history of Sri Lanka for the first time. Our allele-frequency-based analysis showed a tight cluster of Sinhalese and Tamil populations, suggesting strong gene flow beyond

the boundary of ethnicity and language. Interestingly, the haplotype-based analysis preserved a trace of the North Indian affiliation to the Sinhalese population (Fig. 3). Overall, in the South Asian context, Sri Lankan ethnic groups are genetically more homogeneous than others.

Ancient mitogenomes reveals complex maternal history and trade network at ancient city Vадnagar: The ancient township of Vадnagar tells a story of a long chain of cultural diversity and exchange. Vадnagar has been continuously habituated and shows a presence of

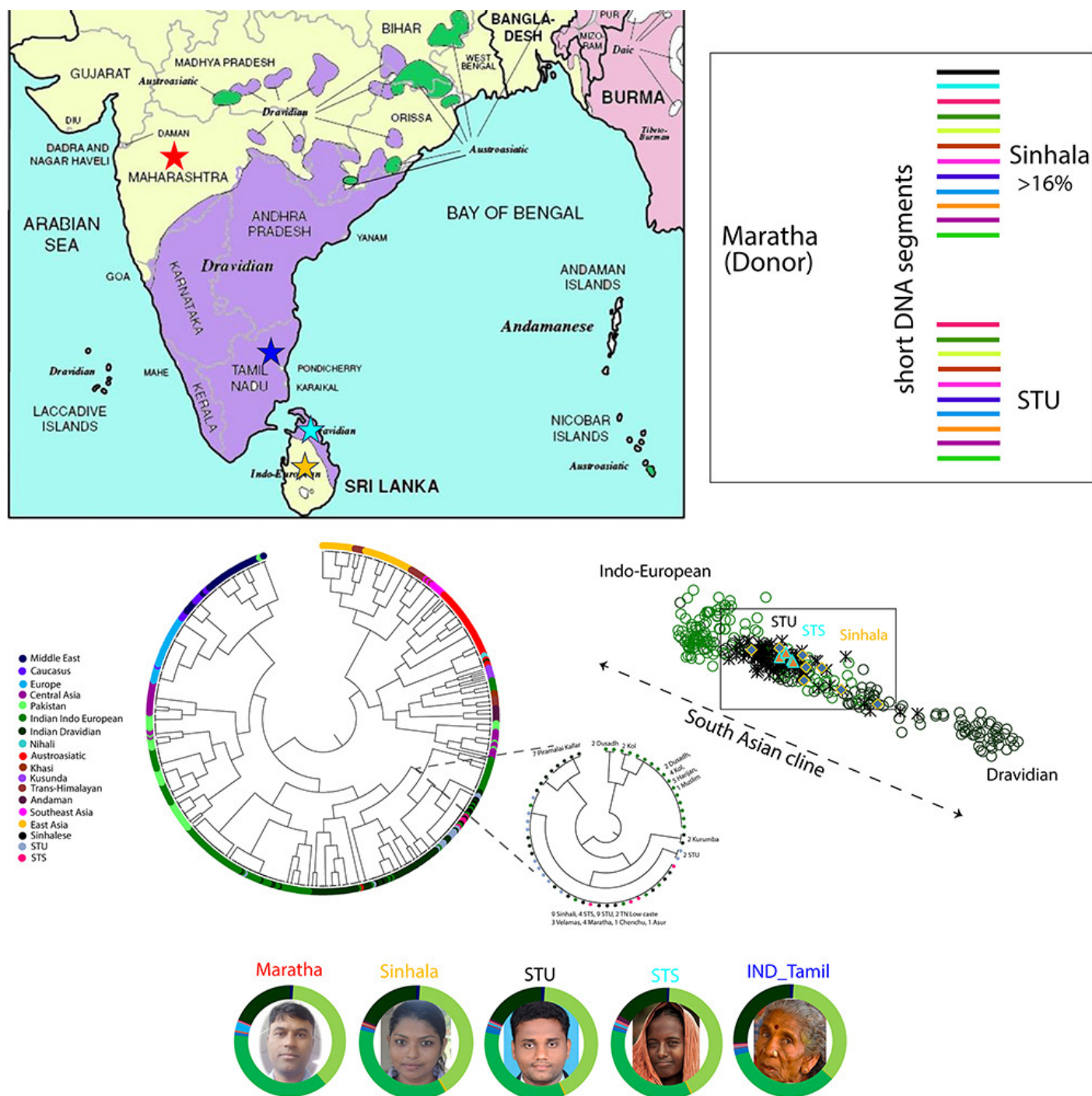


Fig. 3 - Genetic sharing of Sinhalese population with the Indian population groups particularly Tamil and Marathas.

rich cultural amalgamation and continuous momentary sequences between the 2nd Century BCE and present-day. Seven cultural periods developed a complex and enriched settlement at Vadnagar in spatio-temporality. Although archaeological studies done on this oldest settlement suggested a rich cultural heritage, the genetic studies to pinpoint the genetic ancestry was lacking till date. In our current study we have for the first time reconstructed the complete mitogenomes of medieval individuals of the Vadnagar archaeological site in Gujarat. The study aimed to investigate the cosmopolitan nature of the present population as well as the migratory pattern and

the inflow of different groups through trade, cultural and religious practices. Our analysis suggests heterogeneous nature of the medieval population of Vadnagar with presence of deeply rooted local ancestral components as well as central Asian genetic ancestry. This Central Asian component associated with mitochondrial haplotype U2e was not shared with any individual from India, but rather with individuals from the Bronze Age of Tajikistan and with an earlier age of coalescence (Fig. 4). In summary, we propose that the medieval site of Vadnagar in western India was rich in cultural and genetic aspects, with both local and western Eurasian components.

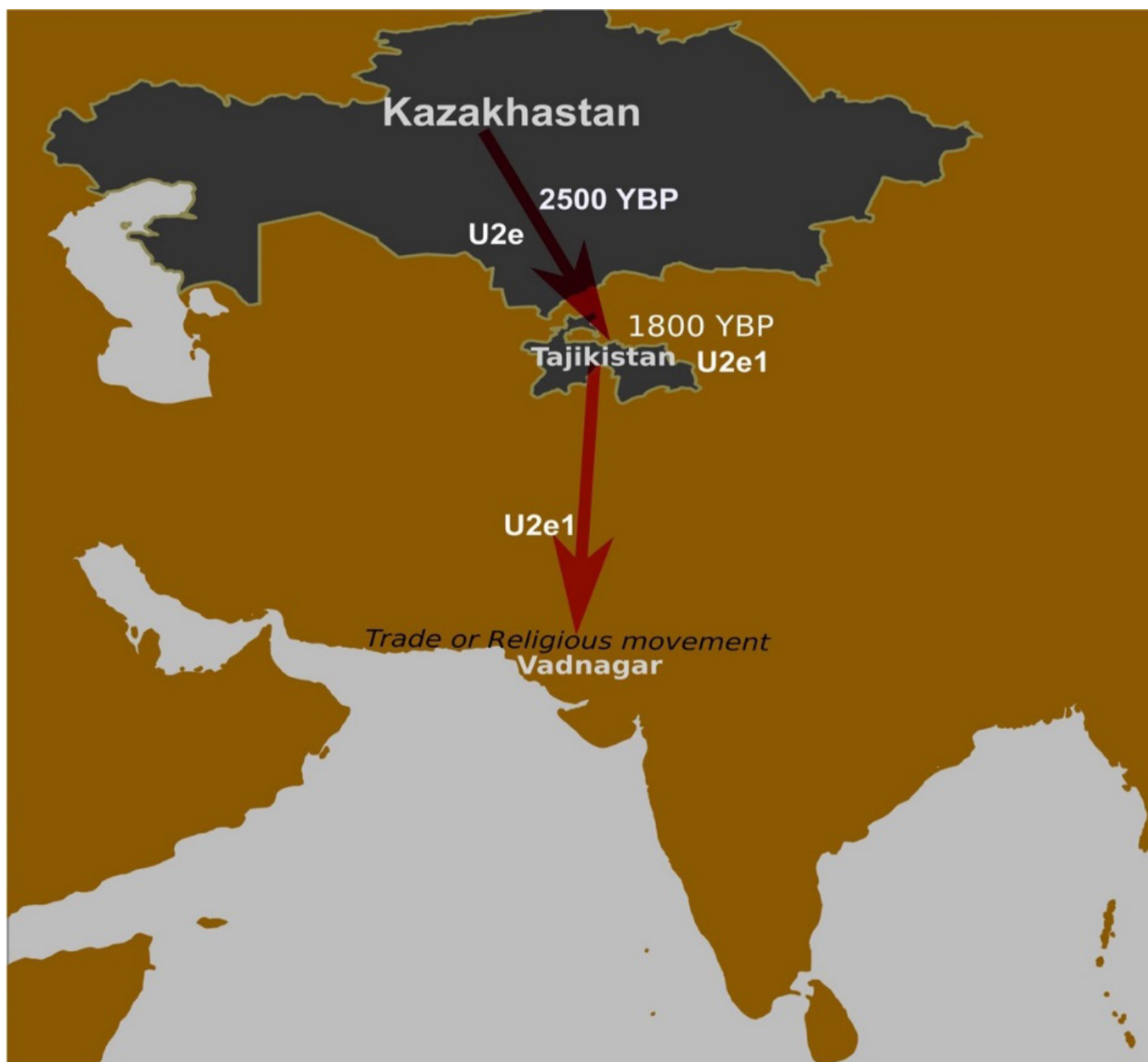


Fig. 4 - The Haplogroup U2e emerged from central steppe (Kazakhstan) at around 2500 YBP, the haplogroup bifurcated into U2e1 around 1800 YBP in Tajikistan. Individuals carrying the U2e1 haplogroup migrated to Vadnagar around 500-600 YBP as a part of trade or religious migrations.







PROJECT OUTCOME

Publication in SCI (Science Citation Index) Journals

1. Ahlawat B, Kumar L, Ambekar A, Sehrawat JS, Rawat YS & Rai N 2024. Ancient mitogenomes suggest complex maternal history of one of the oldest settlements of western India. Mitochondrion 76 (2024): 101871 (IF: 4.4).
2. Kumar L, Rajpal R, Ahlawat B, Sehrawat JS, Spalzin S, Fonia RS & Rai N 2023. The Maternal Genetic Origin and Diversity of the Extant Populations of the Ladakh Region in India. Mitochondrion 101828 (IF: 4.4).
3. Kumar L, Ahlawat B, Kumar S, Tripathy VM & Rai N 2023. Maternal ancestry of first Parsi settlers of India using ancient mitogenome. Mitochondrion 71: 104-111 (IF: 4.4).
4. Kumar S, Singh PP, Pasupuleti N, Tripathy VM, Chauley MK, Chaubey G & Rai N 2024. The genetic admixture and assimilation of Ahom: a historic migrant from Thailand to India. Human Molecular Genetics. Mar 27:ddae054. (IF: 3.5).
5. Pokharia Anil K, Patel H, Ambekar AS, Spate M, Tripathi D, Sharma S, Agnihotri R, Strickland KM,



PH.D. PROGRAMMES

	Himani Patel (2018). Early farming in prehistoric India: New insights into agronomy, genetics and subsistence strategies in North-western and central India, under the supervision of Niraj Rai (BSIP) and R.P. Sinha (BHU), registered with Banaras Hindu University, Varanasi. Status: Awarded (October 2023).
	Sachin Kumar (2020). Tracing early migrations of the Ahom into Northeast India using palaeogenomics and stable isotope approaches, under the supervision of Niraj Rai (BSIP) and Maanasa Raghavan (The University of Chicago), registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: Submitted.
	Richa (2020). The peopling of old-world South Asia: From modern to ancient genome, under the supervision of Niraj Rai (BSIP) and Maanasa Raghavan (The University of Chicago), registered with Academy of Scientific and Innovative Research (AcSIR), New Delhi. Status: In-progress.
	Aparna Dwivedi (2021). Reconstructing Neolithic and Megalithic populations of South Asia using Ancient DNA and Stable Isotope Analysis, under the supervision of Niraj Rai (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Ruchita Yadav (2022). Palaeoethnobotanical investigation of Lower Ganga Plain, with reference to Uren, Bihar, under the supervision of Anil K. Pokharia (BSIP) and Alka Srivastava (CSJMU), registered with Chhatrapati Sahu Ji Maharaj University, Kanpur. Status: In In-progress.
	Mansi Swaroop (2023). Cultural response to Mid-Late Holocene Climate variability in semi-arid N-W India: An Archaeobotanical Approach under the supervision of Anil K. Pokharia (BSIP) , registered with Academy of Scientific and Innovative Research (AcSIR), Ghaziabad. Status: In-progress.

González-Carretero L, Bhushan R, Srivastava A, Yadav R, Shivam A, Dhahi AJ & Singh KP 2023. Agricultural adaptation and resilience through climatic shifts in semi-arid India: 2000 years of archaeobotanical evidence from Vadnagar, Gujarat. *Quaternary Science Advances* **13**: 100155 (IF: 4.5).

- Singh PP, Kumar S, Pasupuleti N, Weerasooriya PR, van Driem G, Tennekoon KH, Rai N & Ranasinghe R 2023. Reconstructing the population history of the Sinhalese, the major ethnic group in Sri Lanka. *Iscience*: 26(10) (IF: 5.8).

Publications other than the Project

- Jagmahender JS & Rai N 2023. Carbon ($\delta^{13}\text{C}$) and Nitrogen ($\delta^{15}\text{N}$) isotope ratios reveal geographic affinity and dietary status of Ajnala skeletal remains: A forensic anthropological study. *Medicine, Science and the Law* 63(4): 298-308 (IF: 1.5).

OTHER ACADEMIC WORKS

Lectures delivered

Niraj Rai

- Advances in Archaeological Sciences and Its implications - Key Note lecture at National Conference

held at Dr. Harisingh Gour University, Sagar, MP on 28th February, 2024.

- Unlocking the Genetic Tapestry of South Asia - Invited talk at International Conference- Global challenges in Environment, Food and Biotechnology for Sustainable Development held at Guru Jambheshwer University, Hisar on 22nd February, 2024.
- Reconstructing the Peopling of Old-World South Asia - invited talk at JRN Rajasthan Vidyapeeth, Udaipur at Department of Archaeology on 27 January, 2024.
- Delivered Invited talk on South Asian Perspectives of Ancient DNA studies at Harvard Medical School, USA on 22nd December, 2023.
- Delivered invited public talk World Anthropological Congress held at Delhi University on the topic- Need of the Anthropological Research in South Asia and challenges on 19th October, 2023.
- Delivered public talk on South Asian Human Population Genomics at Leverhulme Centre for Human Evolutionary Studies, University of Cambridge, UK on 24 September, 2023

Project 8: Quaternary Monsoon/Climate reconstruction through High-Resolution Multi-Proxy studies of Lacustrine Archives from Central India (Core Monsoon Zone and Indo-Gangetic Plain)

COORDINATOR: ANUPAM SHARMA (SCIENTIST G)

CO-COORDINATOR: BINITA PHARTIYAL (SCIENTIST F)

OBJECTIVES

- To reconstruct the palaeoclimate and hydroclimate variability during the late Quaternary using multi-proxy records, and spatio-temporal mapping of abrupt and extreme climate events.
- To assess chronological lag and disparity in long term records and ascertain the causal mechanisms of climate vs. vegetation.
- To study climate-culture interaction in these regions and social response variables.
- Palaeoclimate modelling
- Creation of awareness and outreach for dissemination of knowledge to the society.

PREAMBLE

Agriculture contributes 14% to the country's gross domestic product. The Indian Summer Monsoon (ISM) or Southwest Summer Monsoon (SWM) is responsible for ~80% of the annual precipitation from June to September (JJAS). In contrast, the NEM contributes ~50% of the

annual precipitation on the east coast from October to December (OND). The impact of the ISM variations includes droughts and floods over India and other parts of South Asia, directly affecting agricultural output, economic development and societal well-being of this densely populated region. However, our knowledge regarding the spatio-temporal ISM rainfall (ISMR) variability is limited, underdeveloped and poor owing to the lack of continuous, high-resolution, long-term proxy records from the ISM domain. Still, the relatively short instrumental records of temperature, precipitation, and humidity pose challenges before us. In this backdrop, this project is designed to contribute new information to the existing knowledge on Indian lake records and extend our knowledge of the ISMR variability beyond the instrumental and historical records. Both biotic and abiotic proxy records are instrumental in providing insights into spatio-temporal monsoonal behaviour.

Lacustrine sediments respond directly to regional precipitation changes and are robust storehouses for multiple proxy archives. Long sediment cores from the centre of the lakes have not been raised so far due to logistic restrictions and other technical issues; therefore, the Institute has launched a flagship programme, the



1st Row (L to R): Nitesh K Khonde, S Nawaz Ali, Mayank Shekhar, Ashik Gyaniram Saryam, Jyoti Srivastava, Swati Tripathi, Trina Bose, Md Ikram, Gurusevak Singh; **2nd Row (L to R):** Sadhan K. Basumatary, Santosh K. Shah, Srinivas Bikkina, Prasanna K, Kamlesh Kumar, Anupam Sharma, Binita Phartiyal, Shilpa Pandey, Nazakat Ali, Kishore Katange



Quaternary Lake Drilling Programme (QLDP), to reconstruct the palaeoclimate and hydroclimate variability through the lake sediments of Indo-Gangetic Plain, central Indian Core Monsoon Zone and also from western India.

Moreover, efforts are underway to gather long sediment cores for conducting multi-proxy studies for the high-resolution ISM records during the Quaternary Period, which will not only improve our understanding of the ISMR variability and spatio temporal behaviour but also aid climate modellers in the prediction of future monsoon behaviour.

PERSONNEL

Team Members – Srinivas Bikina (Scientist F), Anjali Trivedi (Scientist E), P.S. Ranhotra (Scientist E), Kamlesh Kumar (Scientist E), Shailesh Agrawal (Scientist D), Jyoti Srivastava (Scientist D), Md. Firoze Quamar (Scientist D), Paulramasamy Morthekai (Scientist D), Prasanna K (Scientist C), Trina Bose (Scientist C), Anurag Kumar (Scientist B), Mayank Shekhar (Scientist B)

Associate Members – Sadhan Kumar Basumatary (Scientist-E), Biswajeet Thakur (Scientist E), Santosh K Shah (Scientist E), Swati Tripathi (Scientist E), Shilpa Pandey (Scientist E), Sheikh Nawaz Ali (Scientist

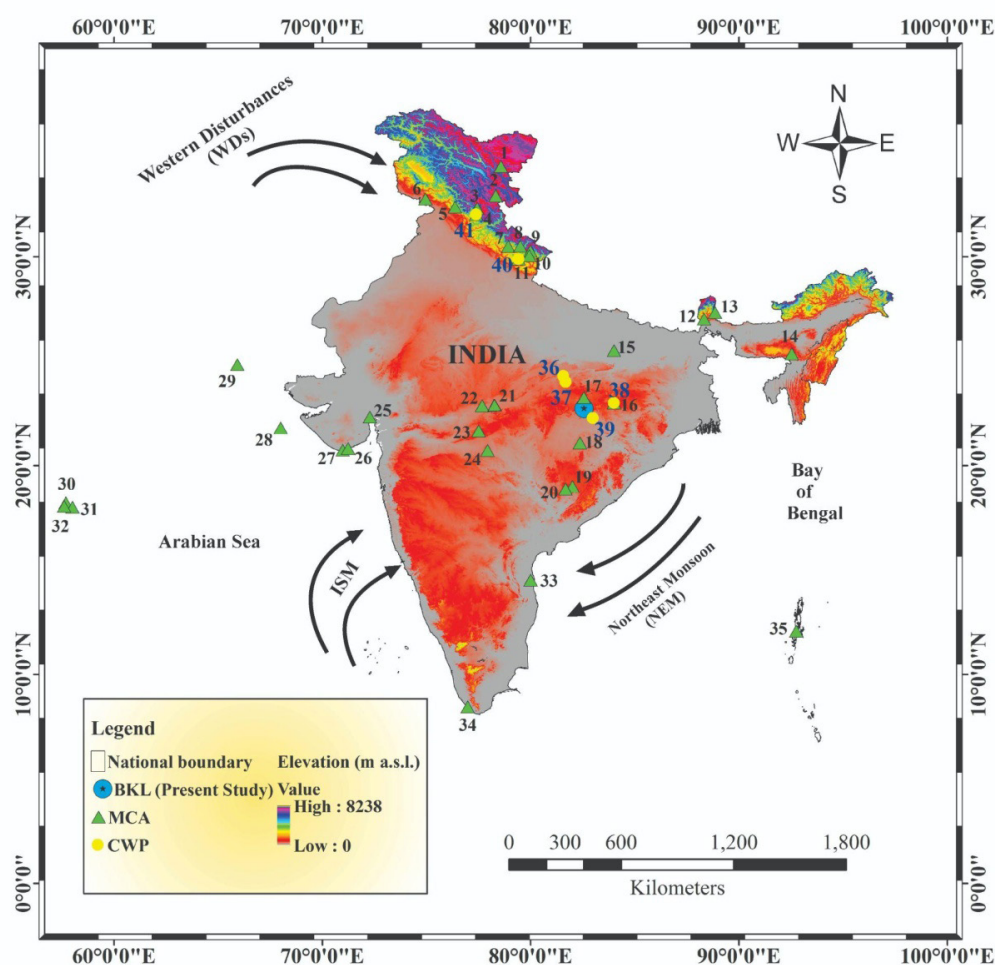


Fig. 1 - Shuttle radar topographic mission (SRTM) digital elevation map (DEM) of India showing the regional correlation of MCA and CWP about the present lake (BL) of the Korba District (purple colour, pentagonal shape). Green triangles show the MCA records: 1. Rawat *et al.* (2015), 2. Dutt *et al.* (2018), 3. Chauhan (2006), 4. Singh *et al.* (2020), 5. Bali *et al.* (2007), 6. Quamar (2022b), 7. Kotlia & Joshi (2013), 8. Kar *et al.* (2002), 9. Bali *et al.* (2015), 10. Ruhland *et al.* (2006), 11. Kaushik *et al.* (2023), 12. Ghosh *et al.* (2018), 13. Sharma & Chauhan (2001), 14. Gupta *et al.* (2019), 15. Singh *et al.* (2015), 16. Chauhan & Quamar (2010), 17. Quamar & Bera (2014), 18. Quamar (2022a), 19. Sinha *et al.* (2007), 20. Sinha *et al.* (2011), 21. Quamar & Chauhan (2015), 22. Quamar & Chauhan (2011), 23. Quamar & Chauhan (2014), 24. Banerji *et al.* (2021b), 25. Sodhi *et al.* (2022), 26. Banerji *et al.* (2017), 27. Banerji *et al.* (2019), 28. Agnihotri *et al.* (2002), 29. Von rad *et al.* (1999), 30. Anderson *et al.* (2002), 31. Gupta *et al.* (2003), 32. Gupta *et al.* (2005), 33. Reddy *et al.* (2022), 34. Banerji *et al.* (2021a), 35. Laskar *et al.* (2013), and yellow circles are the CWP records: 36. Chauhan (2004), 37. Chauhan (2005), 38. Quamar & Bera (2020), 39. Chauhan & Quamar (2010), 40. Kaushik *et al.* (2023) and 41. Singh *et al.* (2020).

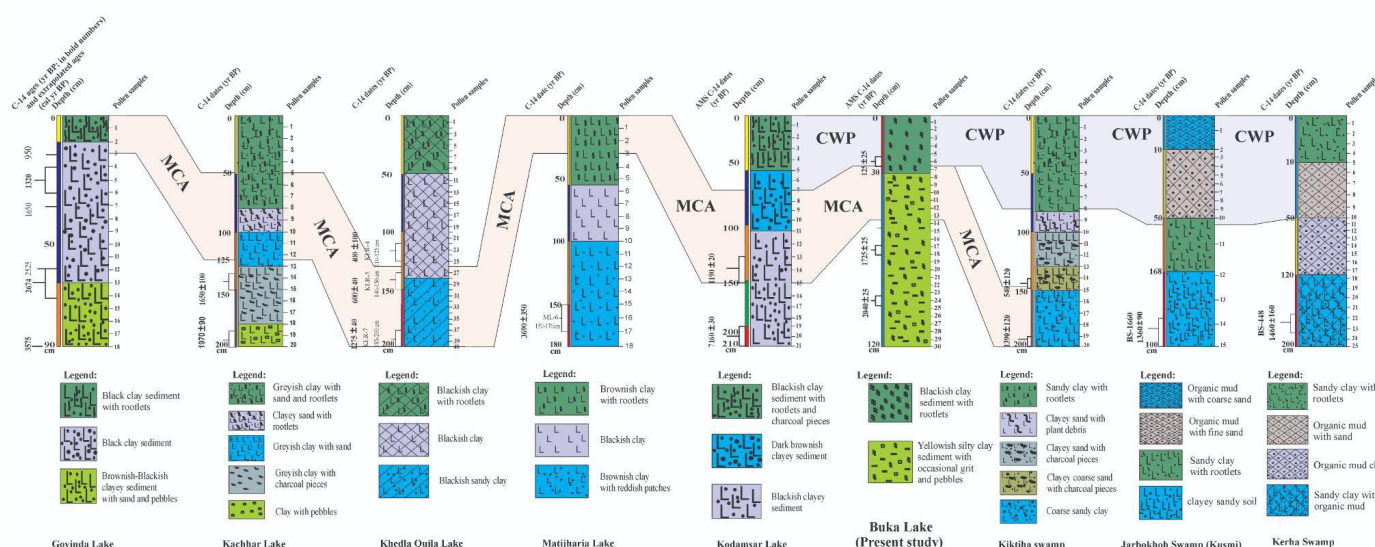


Fig. 2 - Lithological diagrams from central India (especially from Madhya Pradesh and Chhattisgarh States) showing the correlation of the global climatic events, such as Medieval Climate Anomaly (MCA) and Current Warm Period (CWP) in relation to the present study from the Korba District, Chhattisgarh, central India. The inferences of the present study (Buka Lake, Korba District, Chhattisgarh State, Prasad *et al.*, 2024) has been correlated with the inferences of the Govinda Lake, Mahasamund District, Chhattisgarh (Quamar, 2021); the Kachhar Lake, Sehore District, Madhya Pradesh (Quamar & Chauhan, 2011); the Khedla Quila Lake, Betul District, Madhya Pradesh (Quamar & Chauhan, 2014); the Matijhar Lake, Koriya District, Chhattisgarh (Quamar & Bera, 2014); the Kodamsar Lake, Korba District, Chhattisgarh (Quamar & Bera, 2021); the Kikitha Swamp, Shahdol District, Madhya Pradesh (Quamar & Chauhan, 2010); the Jarbokhosh Swamp, Sidhi District, Madhya Pradesh (Chauhan, 2004); the Kerha Swamp, Sidhi District, Madhya Pradesh, central India (Chauhan, 2005).

D), Manoj M.C. (Scientist D), Runci Paul Matthews (Scientist-D), Nitesh Kumar Khonde (Scientist C), Mohammad Arif (Scientist C).

Technical support—D.K. Pal (Technical Officer B), Ishwar Chandra Rahi (Technical Officer A), Amrit Pal Singh Chaddha (Technical Assistant E), Prasanta Kumar Das (Technical Assistant E), Sandeep Kumar Kohri (Technical Assistant D), Ishwar Chandra Shukla (Technical Assistant D), Jitendra Yadav (Technical Assistant D), J. Bhaskaran (Technical Assistant B).

Research Scholars—Arvind Tewari, Pooja Nitin Saraf, Md Ikram, Nazakat Ali, Nagendra Prasad, Jereem Thampan, Mohammad Javed, Manisha MT

SIGNIFICANT FINDINGS

Late Holocene monsoonal climates from the central Indian Core Monsoon Zone

Signatures of the global warm Medieval Climatic Anomaly (MCA; CE 915–1736) and Current Warm Period (CWP; CE 1736 onwards) have been recorded from the Buka Lake area, Korba District, Chhattisgarh, central Indian Core Monsoon Zone (CMZ) (Figs 1–3).

Signatures of 8.2 ka, HCO, MCA and CWP from the Core Monsoon Zone of India : Signatures of the global 8.2 dry event (~8217–4977 cal yr BP), the Holocene Climate Optimum (HCO; ~4977–3775 cal yr BP), the Roman Warm Period (RWP; ~3775–918 cal yr BP), the Medieval Climate Anomaly (MCA; ~918–145 cal yr BP; CE 1032–1805), and the Current Warm Period (CWP; ~145 years BP to the present; 1805 CE onwards) have been observed from the Tuman Lake area of the Korba District, Chhattisgarh, central Indian CMZ.

Millennial to Centennial-scale climate oscillations since 15000 cal yr BP from Kanwar wetland in the Central Ganga Plain

The mineral magnetic and textural analyses, along with chronology, distinctly record variation in the monsoon intensity since 15000 cal year BP in the sediment core collected from the Kanwar Lake of India. During this period, several other palaeoclimatic events, such as the Bølling-Allerød (B/A), Older and Younger Dryas and the short-term fluctuations in the Holocene-Greenlandian, Northgrippian and Meghalayan stages, are observed. The B/A event is correlated with the Indian Summer Monsoon (ISM) intensification period of the Central Ganga Plain (CGP). Eleven dry events are recorded at 13600–13200,

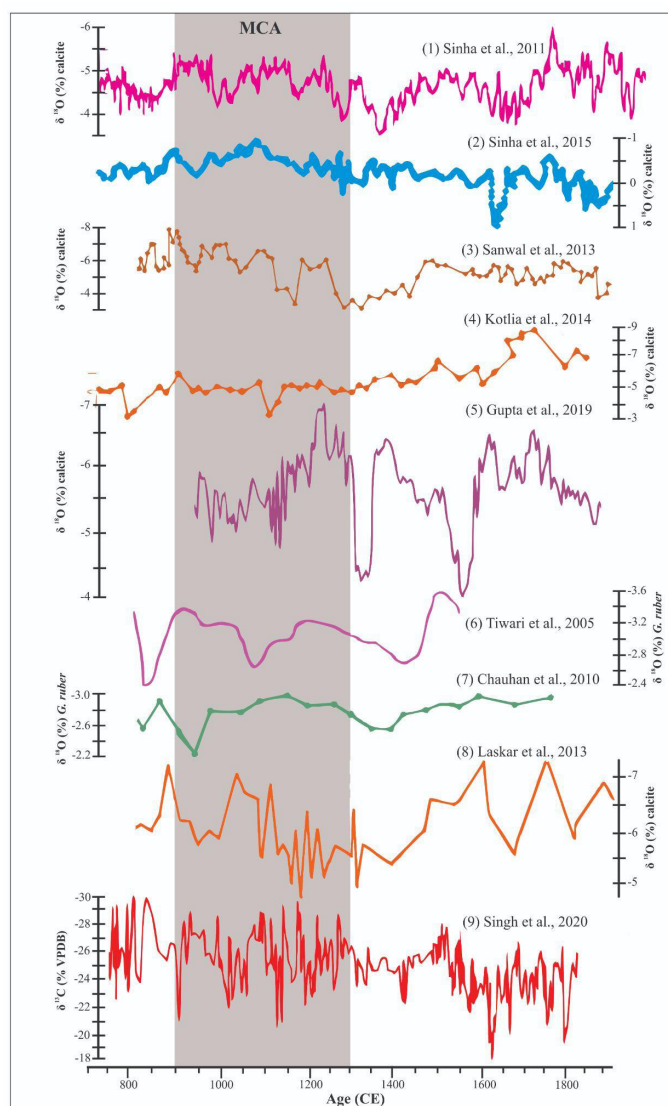


Fig. 3 - Warm and moist climate during the MCA (light blue band) was recorded from various regions (a-i) of the Indian sub-continent; (1). from central India (2). from Lesser Himalayas (3). from Kumaun, Lesser Himalayas (4). from central Himalaya (5). from NE India (6). from Arabian Sea (7). from SE Arabian Sea (8) from the Andaman and Nicobar Islands and (9). from NW Himalaya.

13000–11700, 11000, 10500, 9800–9000, 8200, 6100–5300, 4300–4200, 3800, 1800–900 and 300 years BP. The sustained episodes of weaker monsoon centered around 10600, 8200, 6000, 4200, 2800 and between 1400 to 600 cal yrs BP in the Holocene variability of the mean grain sizes mostly are temporal synchronous with the reduced upwelling intensity in the western Arabian Sea indicating weakened ISM wind strengths. The correlation between terrestrial, marine, and ice records and the correlation of the previously studied records of the CGP have been used to interpret millennial-scale climate changes as well as climatic synchronicity/asynchronicity (Fig. 4).

Palynological assessment of sedimentary section from Kanwar Lake

Palynological analysis of a 300 cm deep sedimentary section from the Kanwar Lake of Begusarai District, Assam suggest five phases of vegetation and climatic alterations based on five pollen zones (I-V) during 13885 to 2729 cal. yrs. BP., with dominance of non-arboreal taxa over arboreal taxa. During 13885 to 12672 cal. yrs. BP., vegetation was scarce with savanna type vegetation under cool & dry climatic regime. The frequency and diversity of arboreal taxa relatively increases during 10546 to 7833 cal. yrs. BP, corresponding to the global Hypsithermal period indicating the strengthening of forest groves and prevalence of mixed deciduous vegetation under warm and humid climatic conditions in and around the study region. The frequent occurrence of crop and ruderal pollen taxa for the last 2279 cal. yrs. BP. (*Cereal*, *Brassica*, *Coriandrum*, *Solanaceae*, *Amaranthaceae*, *Caryophyllaceae*, *Xanthium* and *Asteroidae*) indicates the increased anthropogenic activities (Figs 5-6).

Tree-ring study from Chhattisgarh, Central India

Five tree ring chronologies were prepared based on the 201 tree cores and 19 cross-section samples of teak collected from five sites during the field trip in December 2022 (by SK Shah). The shortest and longest tree-ring chronology is 45 and 239 years, respectively. Except for site BGB, all other sites correlate significantly with each other. Among these, two tree ring chronologies developed from northern Chhattisgarh have been correlated with various climate data, viz. rainfall, temperature, drought and soil moisture. The highest correlation has been observed with monsoon to pre-monsoon soil moisture gridded data (Fig. 7).

Habitat distribution modelling to identify areas of high conservation value under climate change for an endangered arid land tree *Tecomella undulata*

Tecomella undulata is an endangered arid or semi-arid tree with many ecological, medicinal, and economic properties. Despite its ability to withstand harsh climatic conditions, the species is endangered due to anthropogenic effects and climate change (Fig. 8). In this study, we developed species distribution models (SDMs) using MaxEnt to assess the impact of past (Middle Holocene, -6000 years before present), current and future (2050s, 2070s; RCP 2.6 and RCP 8.5) climate change scenarios on *Tecomella undulata* (Fig. 9). We collected 76 occurrence records for the species and analysed them based on 13 environmental factors. The SDM predicted that the distribution of the species was concentrated in the Thar desert region during the middle Holocene and expanded later, corresponding to increased aridity in the Indian subcontinent. The fossil

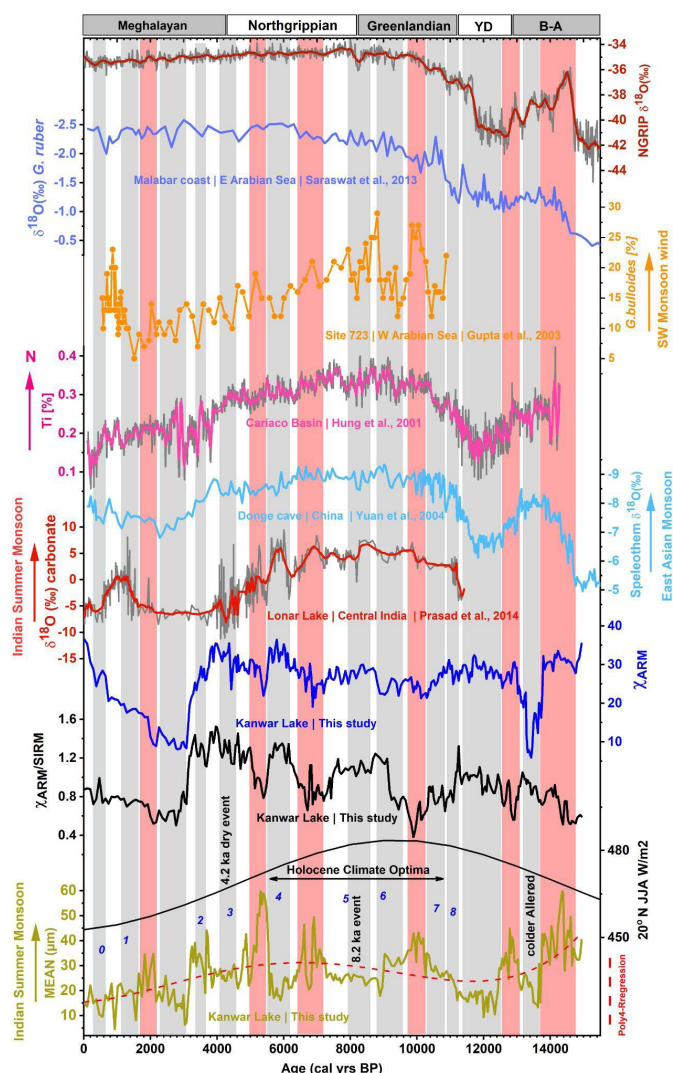


Fig. 4 - Correlation between the Kavar wetland record (mean grain size, $\chi_{ARM}/SIRM$ and χ_{ARM}) and $\delta^{18}O$ NGRIP (with 25 point detrended curve; brown) ice core records (NGRIP Project Members, 2004; Wolff *et al.*, 2010), *G. ruber* $\delta^{18}O$ records from the off the Malabar Coast in the eastern Arabian Sea (Saraswat *et al.*, 2013), *G. bulloides* $\delta^{18}O$ records from the western Arabian Sea (Gupta *et al.*, 2003), Ti records (with 25 point detrended curve; pink) of the Cariaco Basin (Haug *et al.*, 2001), Speleothem $\delta^{18}O$ records of Dongge Cave, China (Yuan *et al.*, 2004), $\delta^{18}O_{carbonate}$ records (with 10 point detrended curve; red) from Lona Lake, Central India (Prasad *et al.*, 2014) and 20°N JJA insolation record (Laskar *et al.*, 2004). The Bond events (0-8), B/A, Older Dryas, Younger Dryas and other glacial / interglacial periods are also indicated. Major decline and increase in ISM is shaded in grey and pink color, respectively.

pollen data verified it. The SDMs predict a decrease in the future distribution of the species. The core distribution also changed with the change in the distribution range. Annual Precipitation (Bio 12), bulk density of soil (BD), and Mean Diurnal Range (Bio 2) play a significant role in the changes. The Annual Precipitation and Mean Diurnal Range are inverse to the distribution, while moderately

high bulk density (1.4-1.6 g/cm³) is favourable for the survival of *Tecomella undulata*. The conservation of the species is essential, and our study identifies northeast Rajasthan and southwest Saurashtra to be given the most priority. With the identification of priority conservation areas and minimizing the negative factors, we can preserve the species from extinction.

Analysis of tree-ring data from the Nichlaul site in Uttar Pradesh

This study presents an analysis of tree-ring data from the Nichlaul site in Uttar Pradesh, focusing on a 94-year tree-ring chronology of Teak (*Tectona grandis* L.f.). The analysis aims to understand the linkages between tree growth patterns, monsoon dynamics, and atmospheric-oceanic circulation in the region. The findings reveal a significant positive correlation between the tree-ring width chronology and both pre-monsoon and post-monsoon precipitation and runoff, indicating the potential of tree rings as proxies for past hydroclimate variability. Furthermore, a negative correlation is observed between tree growth and temperature, highlighting the sensitivity of teak trees to climatic conditions. Also, during the monsoon period, it is observed that Sea Surface Temperature (SST) in the Central Pacific and Indian Ocean shows a significant negative correlation with tree growth and precipitation (Fig. 10). This suggests a complex relationship between monsoon dynamics and oceanic conditions, with implications for future climate projections in the region. Overall, this research provides valuable insights into the climatic variability of Uttar Pradesh and emphasises the importance of tree-ring data in understanding past climate dynamics and predicting future changes.

Analysing the past and future dynamics of the Asian Summer Monsoon: Insights from palaeomonsoon synthesis and CMIP6 data.

The Asian Summer Monsoon is one of the active synoptic scale weather phenomena, and has significant socio-economic implications. A vast population relies on the associated precipitation, mostly dominating the agricultural practices of the region. Therefore, it is essential to assess past behaviour to understand the present, including future projections. We used palaeomonsoon precipitation synthesis and Coupled Model Intercomparison Project Phase6 (CMIP6) data to interactively show the dynamics and changes in the summer monsoon for the Asian region throughout the past millennium behaviour to understand the present and future projections. In this study, we precisely analysed and quantified the dynamics of summer precipitation variation throughout the last millennium (LM; 850–1849 CE) at an annual resolution, in which the major climatic events were the Medieval Warm Period

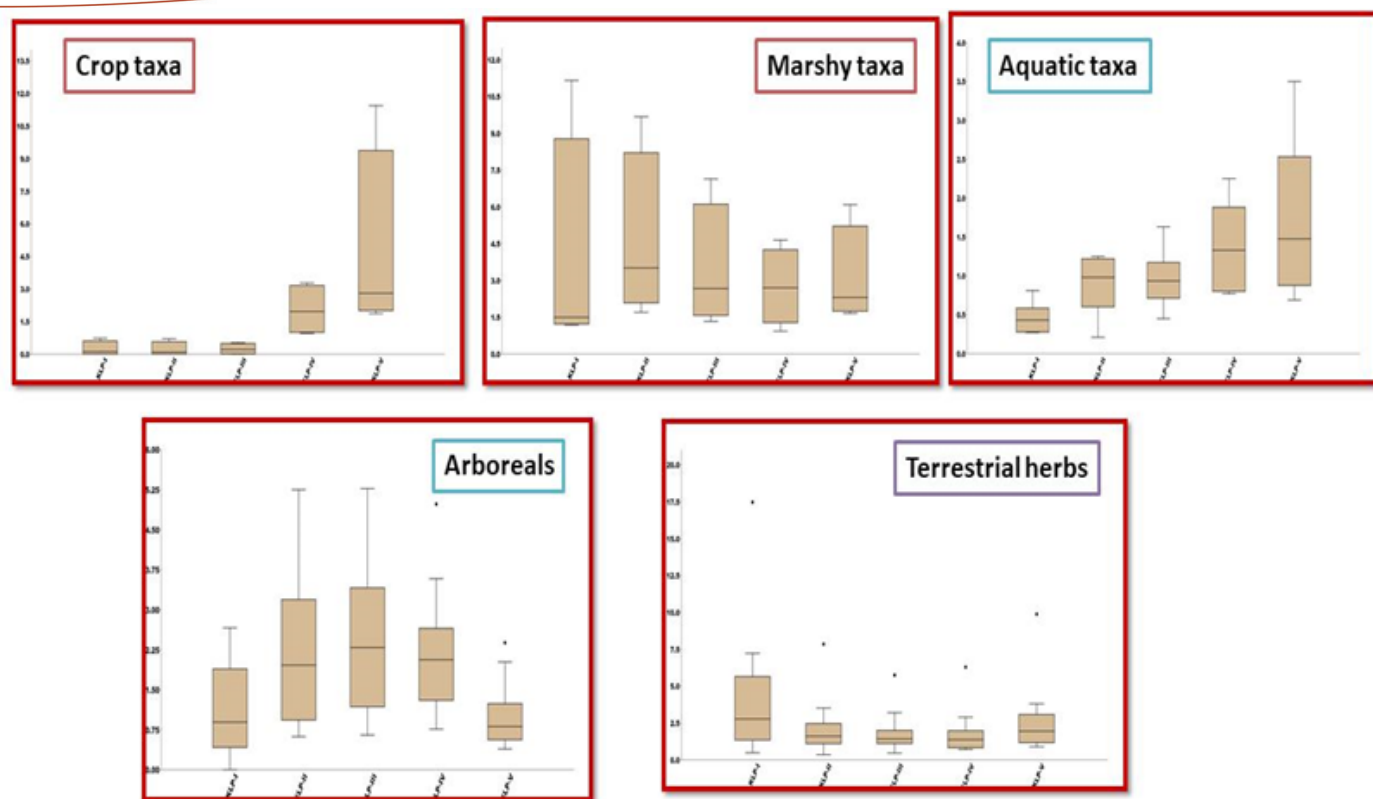


Fig. 5 - Box-plots showing distribution of different pollen taxa in Kanwar Lake sediment samples in Bihar

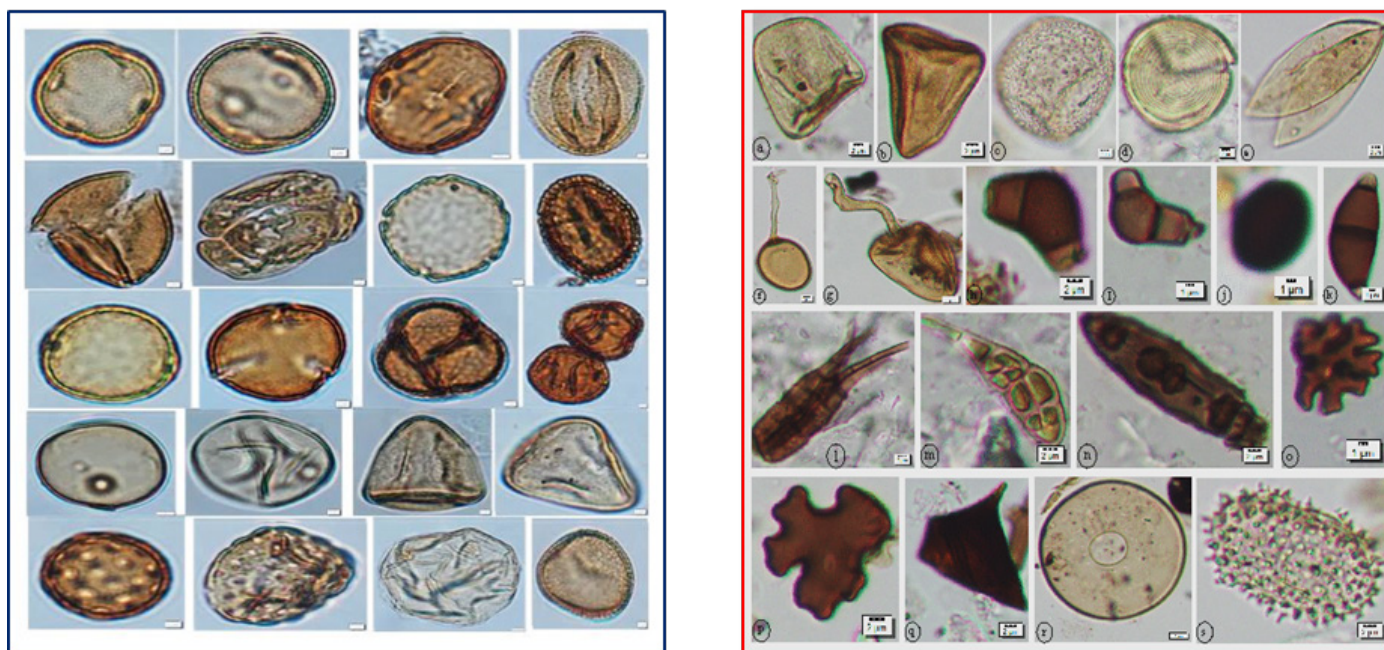


Fig. 6 - Retrieved pollen and non-pollen palynomorphs from the Kanwar Lake sediments of Bihar.

(MWP; 900–1300 CE) and Little Ice Age (LIA; 1500–1850 CE). We also analysed the historical or base climate (HC; 1850–2014 CE) and future monsoons (FM; 2015–2100 CE) using CMIP6 SSP2-4.5 and SSP5-8.5, to project the summer monsoon for Asia and the Indian subcontinent. The findings are encouraging, showing slightly increased precipitation during the MCA and low precipitation during the LIA in Asia. Moreover, the average summer monsoon

daily rainfall remained 6.398 ± 0.634 and 6.310 ± 0.649 mm/d for the MCA and LIA, respectively, indicating a relatively slight variation in the summer monsoon precipitation during these climatic phases. In addition, for the twenty-first century, the CMIP6 projection shows increased summer monsoon precipitation over Asia, particularly in the northeast region. Further, the CMIP6 projections for SSP2-4.5 show 6.457 ± 0.658 mm/d, and

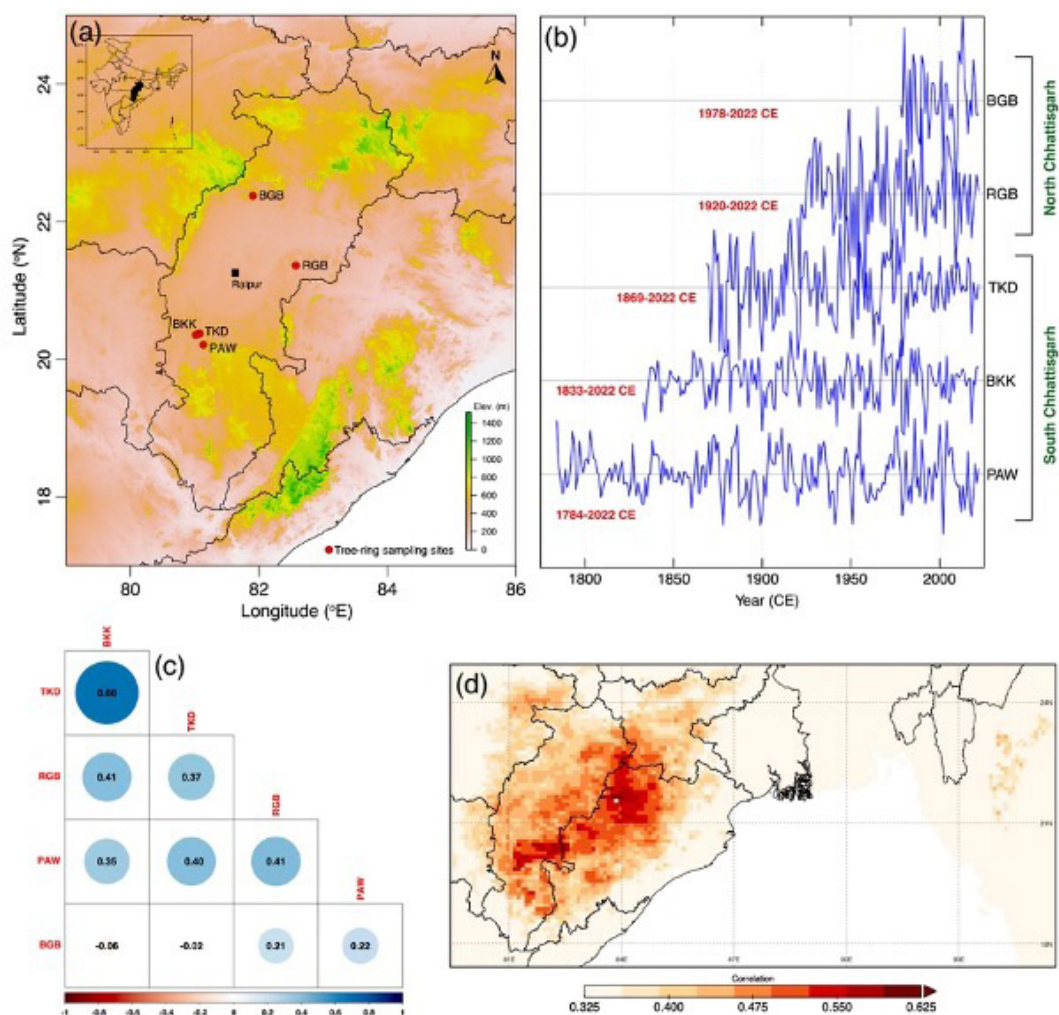


Fig. 7 - (a) Location of tree-ring sampling sites of teak (*Tectona grandis*) in Chhattisgarh, (b) Tree-ring chronologies of teak from five sites of Chhattisgarh, (c) Correlation between five tree ring chronologies (d) Spatial correlation of teak tree ring chronology of RGB site with pre-monsoon to monsoon soil moisture data.

for SSP5-8.5 is 6.686 ± 0.837 mm/d for the twenty-first century (Fig. 11). Furthermore, the results of Empirical Orthogonal Functions (EOFs) analysis suggest that the monsoon system may become more intense in some regions, whereas other regions may experience reduced precipitation in the Asia-Pacific region, with a regionally heterogeneous rise in heavy rainfall and high moisture throughout most of Asia.

Heavy metal pollutants and their spatial distribution in surficial sediments from the Gangetic Plains, central and western parts of India

Systematic analysis of surficial sediments for heavy metal contamination in three different zones: western India, Ganga Plains, and central India was conducted, to estimate the geochemical environment of the surficial soil, five heavy metals, namely Co, Cu, Ni, Zn, and Pb (Fig. 12). The concentrations of analysed elements fluctuated between certain ranges in each zone of

sampling. Enrichment factor (EF) indicated the highest contamination for Co which showed deficient to minimal contamination in 11 samples, moderate contamination in 11 samples, significant contamination in 16 samples and very significant contamination in 1 amongst the 39 samples from various locations in all three zones depicted. The geo-accumulation index suggests that the variability in Co observed was -1.5 to 2.68 indicating augmentation of the Co concentrations in the study areas with respect to background values. Among 39 of the total locations sampled, 20 of them fall in the category of no pollution with respect to Pollution Load Index (PLI), while 18 fall under the category of moderate pollution and one location falls under the category of heavy pollution. A significantly high correlation was observed between Co, Cu, and Zn, which suggests the same source of contamination input source is mainly due to human settlement and agricultural activity. Although all the indices suggested that the zones have not been subjected to extreme levels of pollution yet, the absence of swift and immediate appropriate measures to contain the anthropogenic contamination of these soils

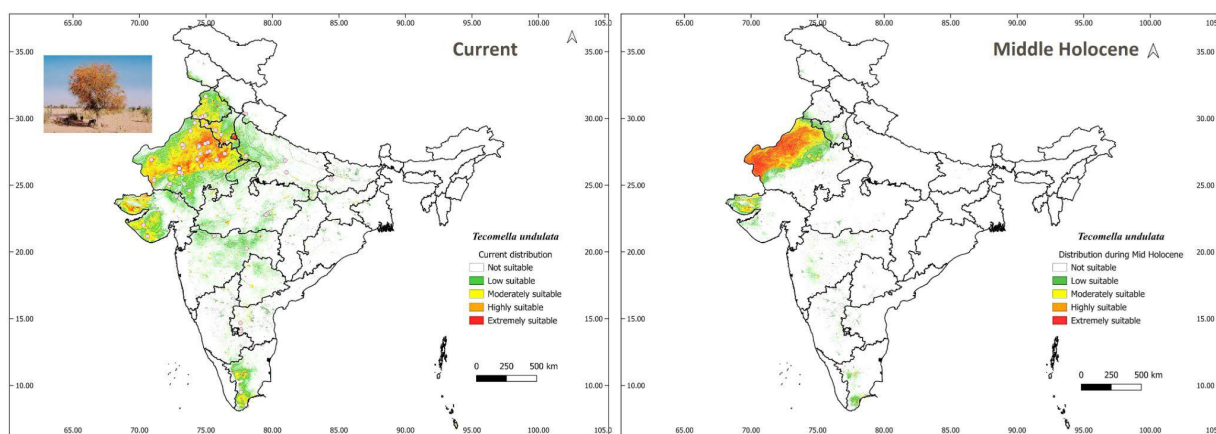


Fig. 8 - Current and middle Holocene distribution of *Tecomella undulata* in the Indian Subcontinent.

can have a detrimental and irreversible impact on the pollution levels. Thus, necessary steps must be taken to preserve the surficial soils and their ecology.

PROJECT OUTCOME

In SCI (Science Citation Index) Journals

1. Quamar MF, Thakur B, Sharma A, Kumar K, Tiwari P, Tiwari A, Prasad N, Srivastava J, Phartiyal B, Manoj MC, Roy I, Saraf PN, Prasanna K, Ali N,

Khan I, Pandey S & Trivedi A 2024. Biotic and abiotic responses deduced through spatially distinct surface samples to reconstruct palaeoecology and palaeoclimate of the core monsoon zone, central India. Journal of the Palaeontological Society of India 124009: 1-16. DOI: 10.1177/0552936024240095 (IF: 0.63).

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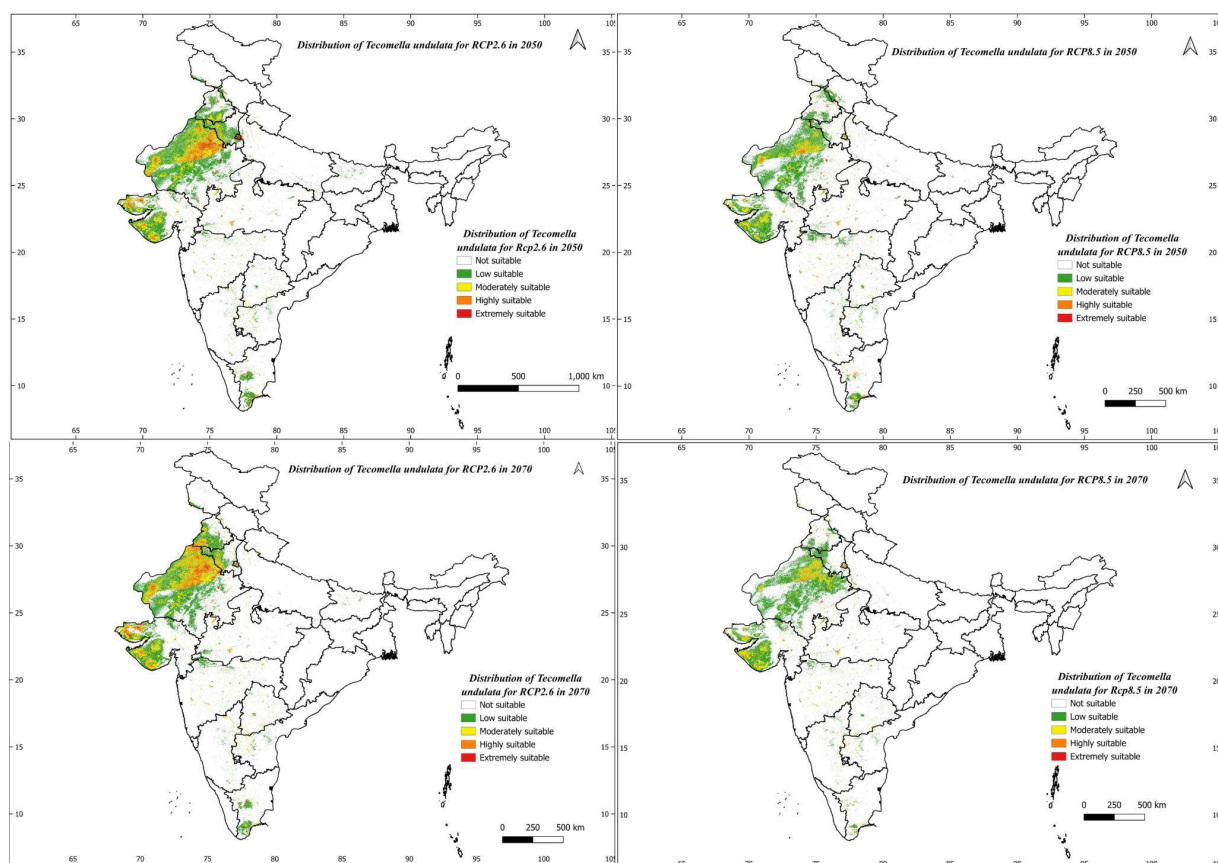


Fig. 9 - Predicted future distribution model of *T. undulata* under RCP 2.6 (2050), RCP 8.5 (2050), RCP 2.6 (2070), RCP 8.5 (2070).

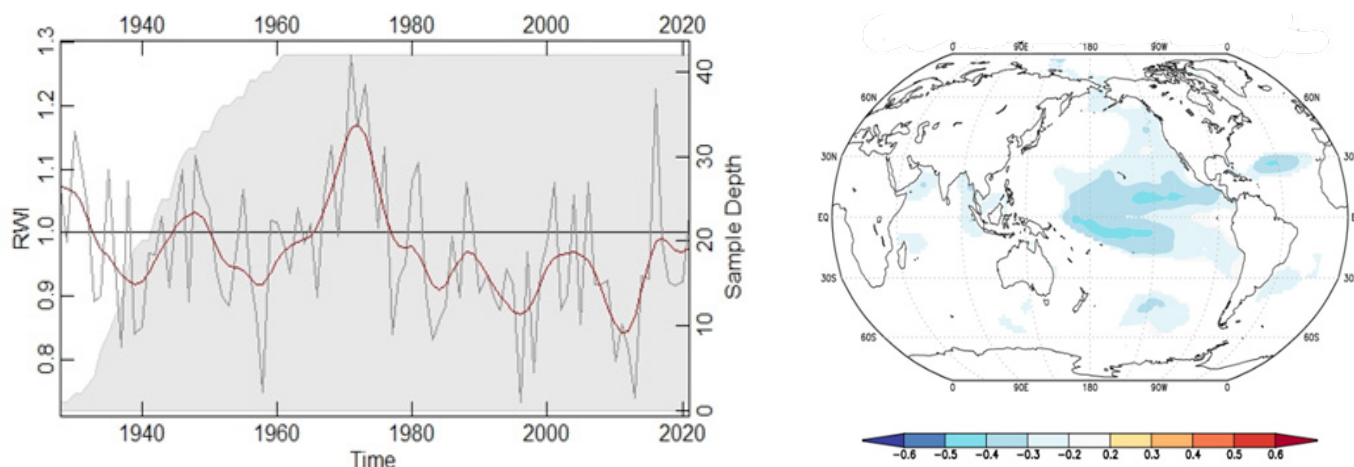


Fig. 10 - Showing the (a) tree-ring width chronology and sample size in grey, with the red line indicating a 10-year low-pass filter. The Spatial correlation patterns between June–September global sea surface temperatures (Extended Sea Surface Temperature, ERSST v 5) and teak tree growth.

- Palaeoclimatology, *Palaeoecology* 633: 111844. <https://doi.org/10.1016/j.palaeo.2023.111844> (IF: 3).
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 5. Saraf PN, Srivastava J, Munoz F, Charles B, Samal P & Quamar F 2024. Using proxy data and vegetation modelling to predict past, current, and future distributional shifts of *Butea monosperma*, a marker of land degradation in India. *Journal of Palaeontological Society of India* 69(1), DOI:10.1177/05529360241240092 (IF: 0.7).
 6. Shekhar M, Sharma A, Pandey P, Sharma A & Dimri AP 2024. Assessing the past and future dynamics of the Asian Summer Monsoon: Insights from palaeomonsoon synthesis and CMIP6 data. *Global Environmental Change Advances*, 2, 100004.
 7. Tripathi S, Thakur B, Sharma A, Phartiyal B, Basumatary SK, Ghosh R, Kumar K, Manoj MC,

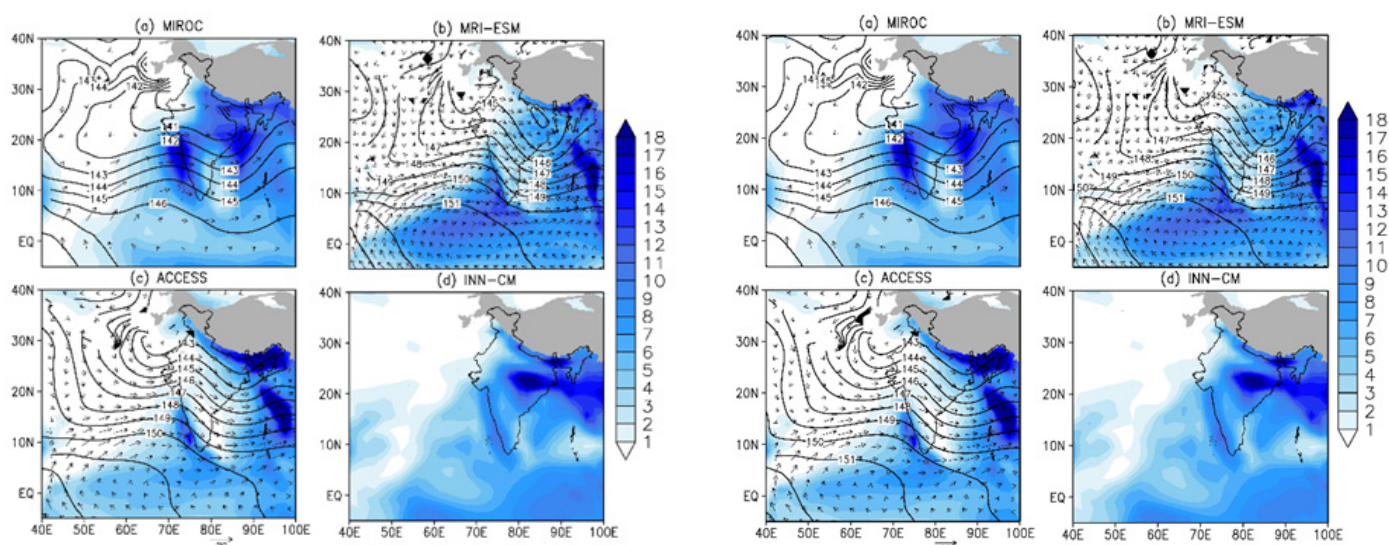


Fig. 11 - Modelled JJAS mean precipitation (mm/day; blue colour); geopotential height at 850hPa (m; black contours), wind at 850hPa (m/s; vector) for the model (a) MIROC (b) MRI-ESM (c) ACCESS (d) INN-CM during (A) MWP (averaged during 900–1300 CE) and (B) LIA (averaged during (1500–1850 CE). The shaded portion corresponds to the Himalayan region above 3000 m.



Agrawal S, Farooqui A, Tiwari P, Saikia K, Tiwari A, Pandey A, Ali Nazakat, Agnihotri R, Prasanna K, Morthekai P, Ranhotra PS, Pandey S & Bose T 2023. Modern biotic and abiotic analogues from the surface soil of Ganga-Ghaghara-Gandak interflaves of the Central Ganga Plain (CGP), India: Implications for the palaeoecological reconstruction. *Catena* 224: 106975. DOI: 10.1016/j.catena.2023.106975 (IF: 6.36).

Research Publication other than the Project Work

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plains in Haryana State of north India: Implications for catchment weathering, provenance and tectonic setting. *J. Earth Syst. Sc.* 132-151. doi.org/10.1007/s12040-023-02155-5 (IF: 1.9).

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6. Farooqui A, Khan S, Agnihotri R, Phartiyal B & Shukla S 2023. Monitoring hydroecology and climatic variability since ~4.6 ka from palynological, sedimentological and environmental perspectives in an Ox-bow lake, Central Ganga Plain, India. *The Holocene* 33(12). https://doi.org/10.1177/09596836231183067 (IF: 2.4).
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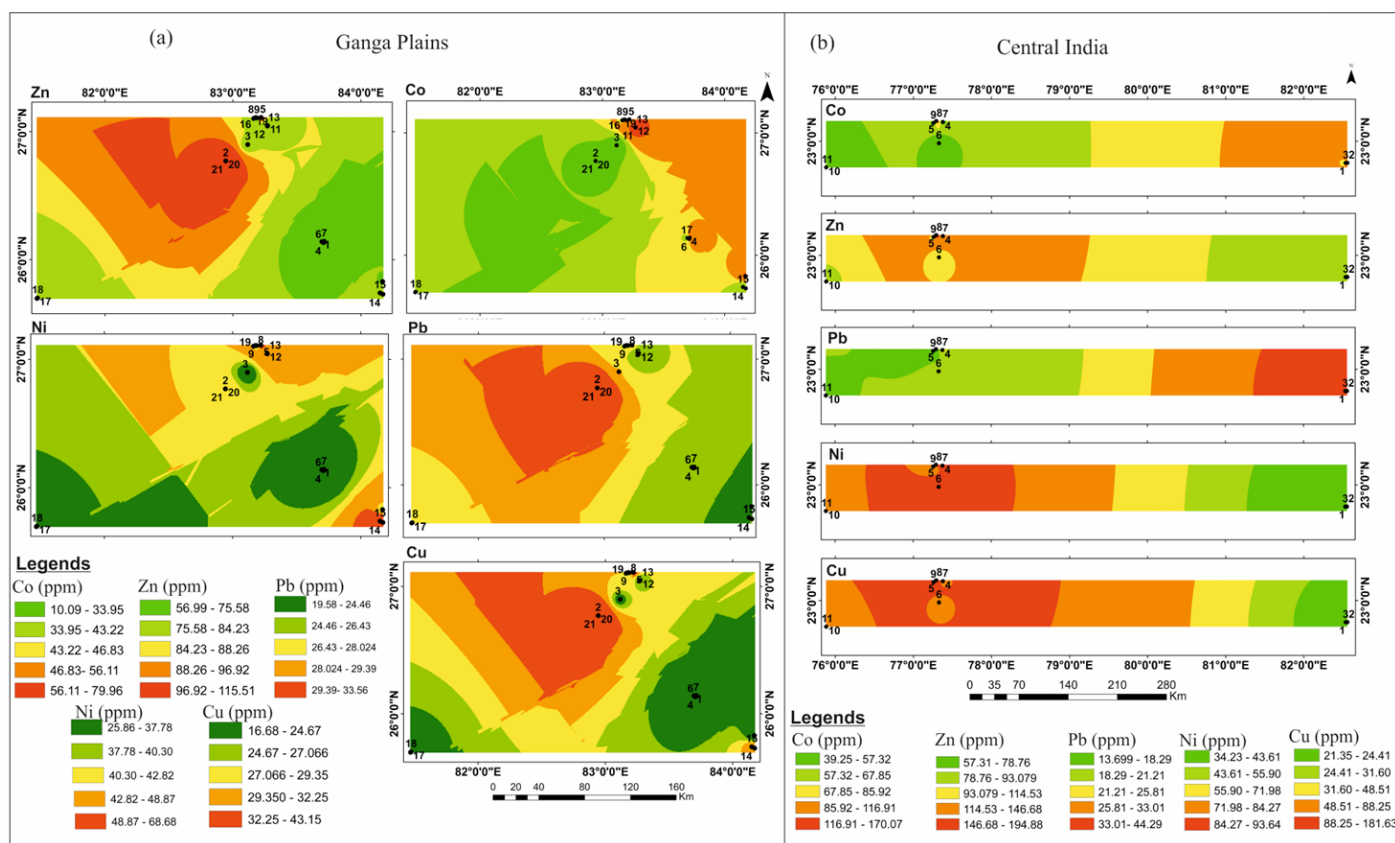


Fig. 12 - Spatial distribution of elements Co, Zn, Pb, Ni and Cu from (a) Ganga Plains and (b) central India are shown in the map.

- Distribution. *Functional Ecology of Plants* 303: 152291. (IF: 2.2).
8. Ghosh R, Saikia K, Biswas O, Agrawal S, Morthekai P, Mohd. Arif, Phartiyal B, Sharma A, Singh N, Paruya DK, Maharana P, Shekhar M & Bera S 2023. Last 10 millennial history of Indian Summer Monsoon in the Bengal region – a multi-proxy reconstruction from a lacustrine archive. *Palaeogeography, Palaeoclimatology, Palaeoecology* 609: 111308 (IF: 3).
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 11. Karri D, Bikkina S & Singh SK 2023. Tracing the provenance of mineral dust over the northern and southern Indian Oceans during the GEOTRACES-India (GI-01, GI-02) expeditions. *Geochimica et Cosmochimica Acta* 366: 141–153 (IF: 5.0).
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 14. Kumar A, Maurya DM, Phartiyal B, Md Arif, Khonde N, Bhushan R & Chamyal LS 2023. Holocene evolution of the Banni plain, NW margin of Arabian sea: constraints from a ~50 m sediment core. *The Depositional Record* 9(4): 1–26. DOI: 10.1002/dep2.241 (IF: 2.54).
 15. Kumar OP, Gopinathan P, Naik AS, Subramani T, Singh PK, Sharma A, Maity S & Saha S 2023. Characterisation of lignite deposits of Barmer Basin, Rajasthan: insights from mineralogical and elemental analysis. *Environ Geochem Health* 45: 6471–6493. doi.org/10.1007/s10653-023-01649-x (IF: 5.13).
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 18. Nag D, Phartiyal B, Agrawal S, Kumar P, Sharma R, Kumar K, Sharma A & Joshi M 2023. Westerly-monsoon variations since the last deglaciation from semi-arid Ladakh region, Trans Himalaya, India. *Palaeogeography, Palaeoclimatology, Palaeoecology* 618: 111515 (IF: 3).
 19. Paraskevopoulou D, Bikkina S, Grivas G, Kaskaoutis DG, Tsagkaraki M, Tavernaraki K & Mihalopoulos N 2023. A direct method to quantify methanol-soluble organic carbon for brown carbon absorption studies. *MethodsX* 11: 102313 (IF: 1.9).
 20. Pillai SSK, Manoj MC, Mathews RP, Murthy S, Sharma A, Saxena A & Pradhan S 2023. Lower Permian Gondwana sequence of Rajhara (Daltonganj Coalfield), Damodar Basin, India: Floristic and geochemical records and their implications on marine incursions and depositional environment. *Environmental Geochemistry and Health*. <https://doi.org/10.1007/s10653-023-01517-8> (IF: 4.2).
 21. Pradhan S, Goswami S, Aggarwal N, Mathews RP, Manoj MC, Pillai SSK & Pradhan S 2023. Integrative study of Permian coal-bearing horizons: biostratigraphy, palaeovegetation and palaeoclimate in the South Karanpura Basin. *Environmental Geochemistry and Health*. <https://doi.org/10.1007/s10653-023-01701-w>. (IF: 4.2).
 22. Quamar MF, Mir IA, Jaiswal J, Bharti N, Dabhi A, Bhushan R, Prasad N & Javed M 2023. Hydro-climatic variability and consequent vegetation response during CE 1219–1942 from the Western Ghats, India. *Catena* 232: 107448. (IF: 6.3).
 23. Ramkumar Mu, Nagarajan R, Athiraa P, Sharma A, Gopika P, Fathima AL, Sugavanam G, Manobalaji A & Mohanraj R 2023. Assessment of heavy metal contamination of sediments in popular tourist beaches of the Kerala State, southern India: Implications on textural and mineralogical affinities and mitigation. *Geosystems and Geoenvironment* 3: 100244. <https://doi.org/10.1016/j.geogeo.2023.100244> (IF: 1.5).
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26. Samal P, Srivastava J, Charles B & Singarasubramanian SR 2023. Species distribution models to predict the potential niche shift and priority conservation areas for mangroves (*Rhizophora apiculata*, *R. mucronata*) in response to climate and sea level fluctuations along coastal India. *Ecological Indicators* 154: 110631 (IF: 6.9).
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28. Trivedi A, Morthecai P, Shukla A, Nag A & Singh DS 2023. Recent pollen spectra from Shimla water catchment sanctuary, Kufri (HP): Implications to interpret Holocene pollen records. *Journal of the Palaeontological Society of India* (2023): 1–13. <https://doi.org/10.1016/j.palaeo.2022.111308> (IF: 0.63).
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In Non-SCI Journals (both from Project and other than the Project)

1. Farooqui S, Quamar MF, Farooqui A, Agnihotri R & Khan S 2023. Palynomorphological and isotopic characterisation of monofloral and multifloral honeys from Lucknow, India. *Journal of Palaeosciences* 72(2): 91-118.
2. Gautam S, Ram-Awatar & Sharma A 2023. Evidence of an early Permian palynomorphs in Ophiolitic Mélange of the Shyok Suture Zone, Eastern Karakoram, Ladakh, India. *Journal of Palaeosciences* 72(1): 29-41. doi.org/10.54991/jop.2023.1856.
3. Shukla MK, Halder P, Kumar K & Sharma A 2023. Fluid-rock interaction in the basement granitoids: A plausible answer to recurring seismicity. *Journal of Palaeosciences* 72(1): 1–8. doi.org/10.54991/jop.2023.1853.

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4. Shukla SK, Chaddha AS, Kumar K, Sharma A, Pandey SK, Kapur VV, Phartiyal B, Shivam A, Dabhi A & Bhushan R 2023. Hot spring diatoms are linked to extreme cold conditions: A new perspective for astrobiological implication from the sinter deposit of Puga hot spring, Ladakh, India. *ESS Open Archive* DOI:10.22541/essoar.170158324.46307742/v1.
5. Prasanna K 2023. Diet of Indus Civilization: Reinterpretations from multi-site-stable isotopic mortuary analysis. *Journal of Palaeosciences* 72(1): 55-58. <https://doi.org/10.54991/jop.2023.1855>.

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2. Kawsar M & Manoj MC 2023. A technical note on sediment End Member Modelling Analysis (EMMA) and its interpretation in the past climate reconstruction. *Palaeosciences Souvenir – Birbal Sahni Institute of Palaeosciences Hindi Magazine* 2, 75-81.
3. Quamar MF 2024. Palynological perspective on understanding climate change in India over the pre-industrial Common Era: a comprehensive review and a critical evaluation. In: Samant B & Thakre D (Editors) - *Applications of palynology in stratigraphy and climate studies*, Society of Earth Scientists Series, Springer Nature: Switzerland. https://doi.org/10.1007/978-3-031-51877-5_7.
4. Uddandam PR, Singh A, Mazumdar A & Manoj MC 2024. Multiproxy (Calcareous nannofossil, benthic foraminiferal and TOC) records from the eastern Arabian Sea: Implications for monsoon induced nutrients and primary productivity changes during the Holocene. In the book entitled ‘Aquatic Ecosystems Monitoring: Conventional to Advanced Remote Sensing] edited by Pandey PC, Srivastava PK, Srivastava S Chapter 4. Taylor & Francis.
5. ज्योति श्रीवास्तव 2023. उष्ण कटिबंधीय वन पारिस्थितिकी तंत्र के लिए प्राथमिकता संरक्षण क्षेत्रों (पीसीए) की भविष्यवाणी करने के लिए प्रजाति वितरण मॉडल । पुराविज्ञान स्मारिका, अंक 2.

General Articles/Reports/Database Published

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- ecological regions of the Monsoon International School and Symposium – 2023 *Journal of Palaeosciences* 72(1): 59–62.
2. Manoj MC 2023. Indian participation in XXI INQUA Congress 2023, Rome, Italy. *Quaternary Chronicle* 5(2): 8.
 3. Phartiyal B, Tripathi S & Manoj MC 2023. XXI INQUA Congress 2023 Rome, Italy: India's successful bid to host the INQUA Congress in 2027. *Journal of Palaeosciences* 72(2): 175-178.
 4. Quamar MF, Srivastava G, Rai N & Ahlawat B 2024. Emerging insights on human histories and past environments in South Asia. *Jour. Geol. Soc. India* 100(3): 455-455.
 5. Tiwari P, Mishra DP, Humane SS, Quamar MF, Thakur B, Humane SK, Mishra A & Rajak M 2023. Conventional, renewable energy sources and climate change perspective for energy security in India. *Jour. Geol. Soc. India* 99: 1784-1785.
 6. Trivedi A, Bose T, Nag A & Reghu N 2023. Landuse-Landcover mapping and modelling using pollen and isotopic data in different ecological regions of the Monsoon (LEM), International School and Symposium (ISS) 2023: A Report, *Jour. Geol. Soc. India* 99:1632-1633. <https://doi.org/10.1007/s12594-023-2517-4>.

SPONSORED PROJECTS (SP) & COLLABORATIVE PROJECTS (CP)

SP 8.1: Fluid-rock interaction at shallow subsurface level in the upper continental crust and its implications in altering the textural, mineralogical and geochemical characteristics of host rocks [Sponsored by MoES, Govt. of India (MoES/P.O.(Seismo)/1(374)/2019)]

Investigators: Anupam Sharma, Scientist-G, BSIP, Lucknow (PI), Kamlesh Kumar, Scientist-D, BSIP, Lucknow (CO-PI 1), Matsyendra Kumar Shukla, Scientist-C, BGRL (CO-PI 2), Piyal Halder (JRF, SAGE-MOES)

As a part of the International Continental Deep Drilling Program in the Koyna Seismogenic Region, core samples of basement granitoids have been collected from the Core Repository of the Borehole Geophysics Research Laboratory (MoES-BGRL) with an objective to delineate the chemically altered zones due to fluid-rock interaction and its role on the seismicity. The mineralogical analyses including XRD, SEM-EDS, and optical microscopic studies reflect precipitation of secondary calcite in the

fractures and the formation of several clay minerals such as Chlorite, illite, etc. on the fault slip surface as a consequence of fluid-rock interaction (Fig. SP 8.1(a)). Geochemical dataset also supports the biotite to chlorite conversion and the formation of illite, epidote in addition to the precipitation of calcite as the by-products of the propylitic grade of hydrothermal alteration (Fig. SP 8.1(b)). The strength of the hydrogen bonds in the chlorite crystal helps to accommodate stress acting at the fault and fractures which facilitates the creep motion and prefers intermittent release of accumulated stress through several small magnitude earthquakes as observed in the last five decades since 1967 ($M_w < 1$). Thus, the outcomes of this MoES-SAGE sponsored project have not only fetched light on the mineralogy and geochemistry of the subsurface fluid-rock interaction in the basement granitoids of the Koyna-Warna Seismogenic Region but also explained the recurring pattern of seismicity with the help of chemistry-a perfect match making of geochemistry and geophysics.

SP. 8.2 The Landcover-Landuse of ecological regions of the Monsoon (LEM) project, as approved under the Humans & Biosphere Commission (HABCOM) of INQUA, is hosted at the Birbal Sahni Institute of Palaeosciences (BSIP), Lucknow.

Investigators: Trina Bose, Scientist-C (PI), BSIP, Anjali Trivedi Scientist-E (Co- PI), BSIP and Navya Reghu (Co-PI)

The multi-year project from the International Union for Quaternary Research (INQUA), titled “Landuse-landcover mapping and modelling using pollen and isotopic data in different ecological regions of the monsoon”, led by Dr. Trina Bose, BSIP (corresponding) with Dr. Navya Reghu, Manipal Academy of Higher Education and Dr. Anjali Trivedi, BSIP held the LEM-International School and Symposium (ISS) – 2023 during 13th to 26th March 2023 in tropical dry deciduous forests of western Vidarbha, Maharashtra, India. Twenty-three trainees from India, Nepal and Sri Lanka interacted with experts from India, Sri Lanka, France, Austria, the United Kingdom, and the United States of America.

South Asian Biodiversity Portal (SABDP) is a principal component of the LEM project to integrate the available and generated information data from archaeological, palaeoenvironmental and ecological sources, resulting in an open-access database via the NEOTOMA infrastructure with additional variables, tools, etc. This will form a sound foundation for exploring future research avenues in quaternary studies for South Asia and is ready for integration to address ongoing discourses in global analysis. SABDP has an email ID ‘southasianbiodiversityportal@gmail.com’ and URLs “sabdp.org.” and “sabdp.net” with the

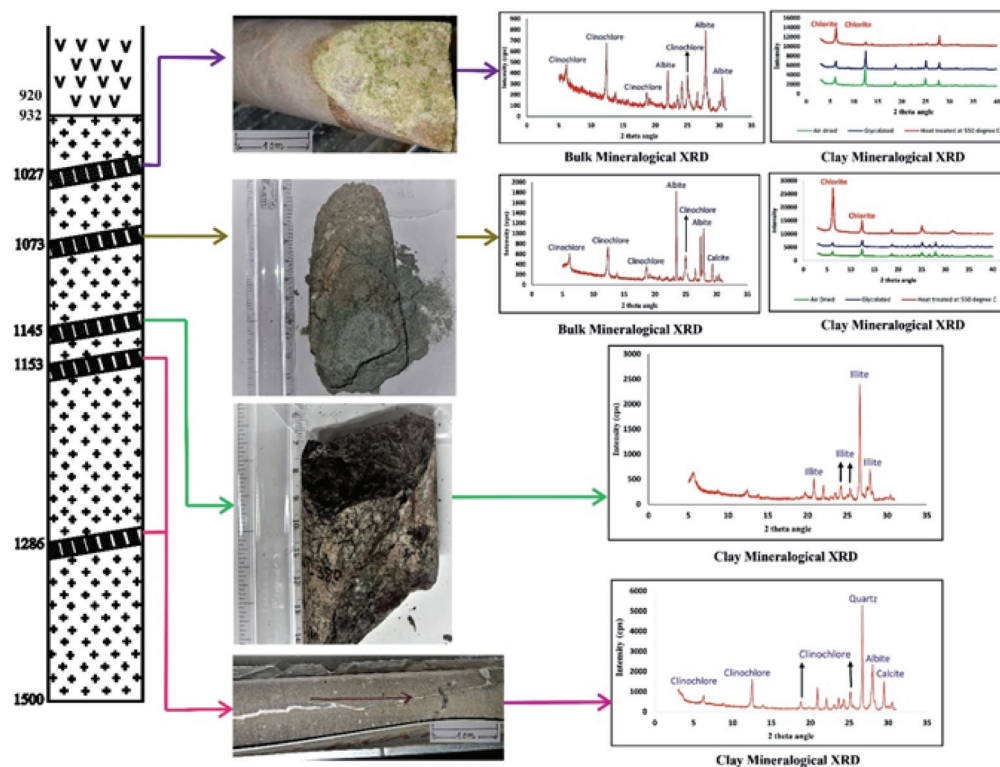


Fig. SP 8.1(a) - The litholog shows the Neoarchaean granitoids basement rocks of the Koyna Warna Seismogenic Region, recovered from a borehole KBH1 near Koyna Dam, overlain by the porous and vesicular deccan trap basalt. The altered fault zones are marked which have revealed the signature of fluid interaction in the mesoscopic observation and have been characterised by the presence of different secondary minerals such as Clinocllore, illite, calcite, etc. in the bulk and clay mineralogical XRD.

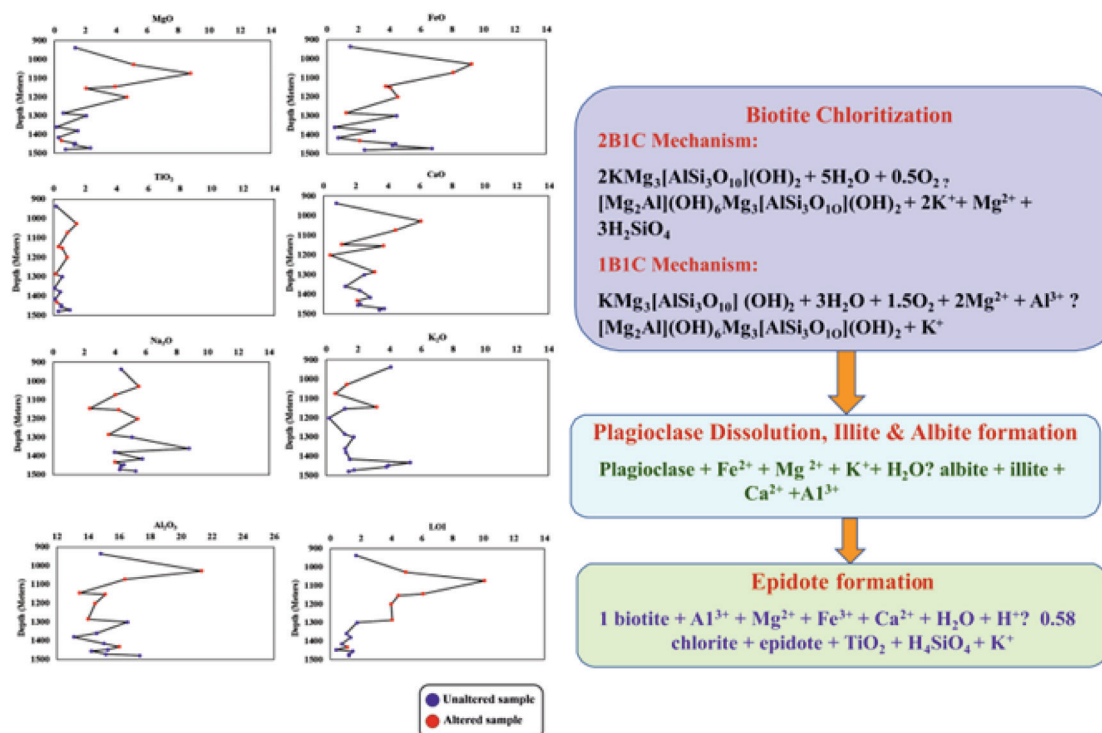


Fig. SP 8.1(b) - The major elemental study of the basement rock samples shows the enrichment of MgO, FeO, Al_2O_3 and depletion of K_2O in the altered fault zones revealing the transformation of biotite into chlorite through the dissolution of potassium interlayer sheet and its subsequent replacement by Mg rich brucite like sheet. A particular horizon indicates the contrasting enrichment of K_2O which is due to the illite formation. The entire mechanism of different secondary minerals formation is shown in form of a flow chert which characterises the propylitic grade of hydrothermal alteration in these subsurface fault zones.

governing council (SABDC) formed in conjunction with the Association of Quaternary Researchers (AOQR). The first meeting of SABDC was held online on 02-02-2024. Discussions are ongoing with the NEOTOMA team for the computational and hosting required for the software, APIs, etc. Hosting options are being explored, with costs to be adjusted in LEM project funds kept for this purpose.

Fieldwork for various sp. flowers, leaves, roots, etc. and surface sediments in the Vidarbha region for the post-monsoon flowering season during Oct-Nov 2023.

Samples collected during LEM-ISS-2023 and the post-monsoon flowering season are under various stages of processing and analysis.

SP 8.3: Quantification of pollen-based reconstructions of Holocene land cover of Southwest India for Earth system modeling (Sponsored by SERB-SUPRA Project No. SPR/2022/000353).

Investigators: Jyoti Srivastava, BSIP, Lucknow, Ravikanth G, Centre for Biodiversity and Conservation, Ashoka Trust for Research in Ecology and the Environment (ATREE), Bengaluru, Karnataka & Ganesan R, Suri Sehgal Centre for Biodiversity Conservation, Ashoka Trust for Research in Ecology and the Environment (ATREE), Bengaluru, Karnataka

A reconnaissance field survey was conducted in December 2023 for selecting the sites for quantification of past land cover. Selected sites were proposed for further permissions from the Karnataka Forest Department in January 2024. Vegetation data and sediment samples were collected from regions around Davanagere, Karnataka. The landscapes visited in the first fieldwork mainly comprise of a mosaic of plantation, human habitation and natural vegetation. Natural vegetation is broadly divisible into four categories, i.e. grasslands, scrubs and forests. The natural forests in

these sites have been classified as tropical dry teak-bearing forest and dry deciduous scrubs. The forest types identified in the region ranged from moist evergreen to dry deciduous along with diverse habitats such as *Myristica* swamps and rocky terrain. *Dipterocarpus indicus* and *Vateria indica* represented the primary forests, especially sacred groves while *Olea dioica*, *Polyalthia fragrans* and *Terminalia paniculata* were the common tree species recorded for their distance weighted plant abundance data.

SP. 8.4: Reconstruction of Arabian Sea coastal upwelling conditions and seawater temperature gradient during Miocene (Burdigalian), India: Insights from Stable and Clumped isotope analysis of otoliths and molluscan fauna (Sponsored by SERB-CRG/2022/003341).

Investigators: Prasanna K, Scientist-C, BSIP, Lucknow (PI), Vivesh V Kapur, Scientist-D, BSIP, Lucknow (CO-PI), Amal MS (JRF, SERB, CRG)]

The Quilon section that lies in the southern part of the onshore Kerala Basin at the base of sea cliffs extending into Ashtamudi Lake (N 08°58'36", E 076°38'08") was studied. This place is part of Padappakkara Village, 5.4 km west-northwest of Kundara, and locally known as 'Channa Kodi'. It corresponds to the outcrop studied by Dey (1961) and Menon (1967a, b) and is the type locality of the Quilon Limestone. The Cenozoic sedimentary succession in the onshore part of the Kerala Basin is dominated by siliciclastic sediments with interbedded lignite seams. Elevation and denudation of the Western Ghats at the rift shoulder was the source for siliciclastics (Campanile *et al.*, 2008). Ostracod faunas and palynofloras from these deposits document deposition in marginal marine brackish lagoons as well as brackish and freshwater swamps (Rao & Ramanujam, 1975; Rao, 1995). The samples of the carbonaceous shale of Quilon beds in Pozhikkara



Foraminifera



Otoliths



Ostracods

Fig. SP 8.4(a) - The samples of the carbonaceous shale of Quilon beds in Pozhikkara cliff section where analysed to derive fossil microfauna, dominated by benthic foraminifers, ostracods and fish otoliths mainly gobiids.

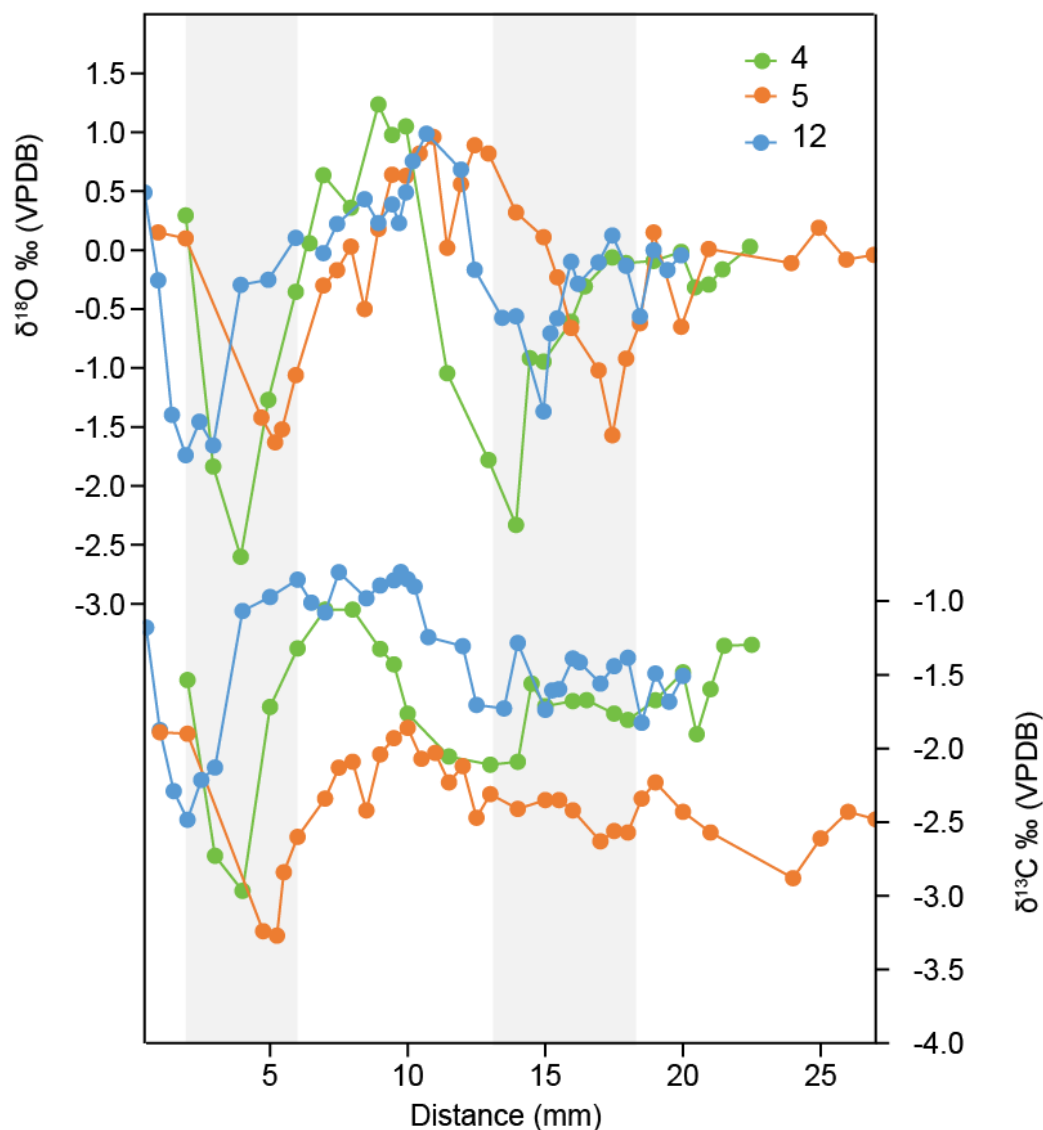


Fig. SP 8.4(b) - $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ data from the shell of a bivalve *Corbulidae* cf. *L. trigonalis* collected from Chhasra Formation, Kutch, India. The bivalve provides an insight into annual temperature cycles during the Burdigalian.

cliff section were analysed to derive fossil microfauna, dominated by benthic foraminifers, ostracods and fish otoliths mainly gobiids (Fig. SP 8.4(a)).

Studies of the oxygen isotopes of the growth bands of three specimens of bivalve *Corbulidae* cf. *L. trigonalis* (Sowerby 1840) from Kutch, Gujarat State, western India, was conducted. The shell length was ~40 mm and the seasonal growth rate was deduced to an average of 2 mm/month based on the *Corbulidae* *Corbula trigona* species which has a reported lifespan of 2 years (Kidwell & Rothfus, 2010). This sample had $\delta^{18}\text{O}$ shell values that indicated a strong seasonality. In the present investigation, the $\delta^{18}\text{O}$ values for the bivalve *Corbulidae* cf. *L. trigonalis* range from -2.6‰ and 1.23‰ VPDB while the $\delta^{13}\text{C}$ values for this taxon vary from -2.9 to -0.8‰ VPDB (Fig. SP 8.4(b)).

The analysed section of the shells recorded a two-year cycle of $\delta^{18}\text{O}$, reflecting the seasonal temperature change

(Fig. 2). When plotted on a $\delta^{13}\text{C}$ vs $\delta^{18}\text{O}$ cross-plot (Fig. SP 8.4(c)), samples cluster together, irrespective of the sampling depth. Elemental analysis of the sample is done using the Inductively Coupled Plasma - Optical Emission Spectrometry (ICP-OES) facility at the Birbal Sahni Institute of Palaeosciences, Lucknow, India. The seasonal range in Lower Miocene (Burdigalian) water temperature in the Indian Ocean is calculated from different samples using different Mg/Ca-temperature equations. Mg/Ca ratios from the specimen display a cyclic pattern. The Mg/Ca ratio values for a specimen range from 1.12 to 10.23 mmol/mol. Mg/Ca – Temperature calibration for an estuarine oyster, *Crassostrea gigas* from marine settings ($\text{SST} = 3.77 \times \text{Mg/Ca} + 1.88$; T in °C and Mg/Ca in mmol/mol; Mouchi *et al.*, 2013). By using this equation we got a temperature range which is comparable with Seawater temperatures calculated from the $\delta^{18}\text{O}_{\text{sw}}$ values of sharks, rays and fish (Cappetta, 1987; Nelson *et al.*, 2016). The temperature for the locality of Mendouillet and Monbalon-

Miron, respectively in France during the Miocene ranges from 14 °C to 29 °C with a mean value of 23 ± 4 °C and from 15 °C to 30 °C with a mean value of 24 ± 4 °C (Goedert *et al.*, 2017).

SP 8.5: The role of water isotopes in understanding the hydrological cycle and its implication to palaeoclimatic studies (Sponsored by SERB Startup Research Grant Project Number: SRG/2023/002252; w.e.f. 30 October 2023).

Investigators: Anurag Kumar Scientist - B (PI) , SERB Startup Research Grant

The hiring of research personnel for the SRG Project has been completed. The necessary equipment for field data measurement and sample collection has been procured. The remaining procurements are in progress. Fieldwork was conducted in the local area of Lucknow to study the isotopic variability of Gomti River water and to test the working of procured instruments. Several published research papers were reviewed to strategically plan the sampling of rivers and groundwater in the Ganga River Basin.

SP 8.6: The British Academy's Leverhulme Small Grants (SRG22\220841)

Investigators: Binita Phartiyal, recipient of grant from University of Bristol, UK (British Science Academy, UK) (2022-23).

The project focused on the threats to water security in Changthang due to climate change, development, tourism, and increased securitization and conflict. This interdisciplinary approach sought to provide a comprehensive understanding of water cultures and knowledge systems by examining historical, folkloric, and traditional associations with water, as well as current adaptive practices and management strategies. The Himalayan region, including Ladakh, is facing challenges like glacier recession, natural dammed lakes, lake outbursts, flash floods, and cloud bursts due to global warming water supply in these villages depends on precipitation influenced by Westerly and ISM atmospheric circulation. Cultural aspects, such as petroglyph sites were highlighted along the Leh-Batalik route, and the 'chubi' areas of Leh, which are at risk of groundwater pollution. LAMO organised heritage walks and an exhibition featuring student artwork from Gya, Puga, and Chumathang, showcasing water heritage. A documentary highlighted the impact of climate change on local people, and a workshop taught techniques for creating artificial glaciers to address water shortages. The survey found that while the water balance is changing, the situation is currently manageable. However, further mitigation and increased climate change awareness are crucial to prevent future challenges for the region's inhabitants. A one-day workshop on water availability and security in Ladakh, focusing on past, present, and future scenarios, was held at Ladakh University.

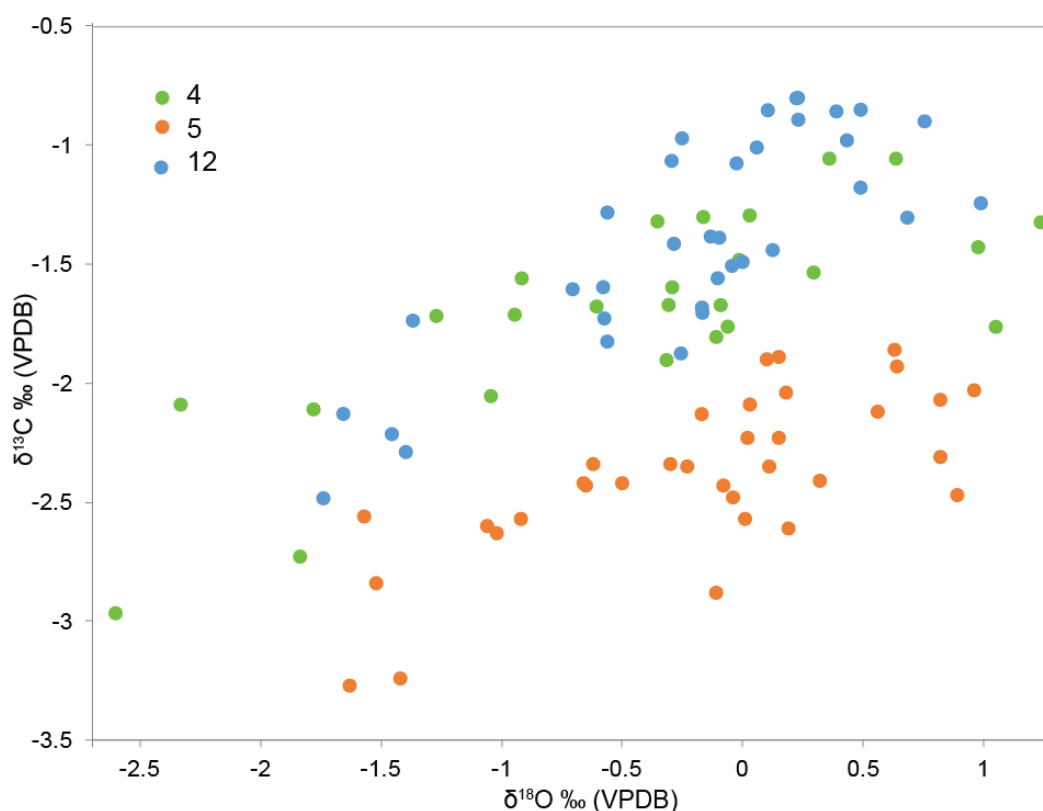


Fig. SP 8.4(c) – $\delta^{13}\text{C}$ vs. $\delta^{18}\text{O}$ cross-plot. Cross-plot of carbon and oxygen isotopic ratios for all three (namely 4, 5, 12) *Corbulidae* cf. *L. trigonalis* samples analysed in this study.



CP 8.1: Reconstruction of vegetation dynamics and contemporary climate (change) during the Holocene from Kumaun Lesser Himalaya.

Md. Firoze Quamar [& Anoop K Singh, University of Lucknow]

Pollen analysis of a 3.73-m-long sediment core from the Deoria Lake, western Himalaya, India. The study demonstrated that between ~5100 and 3125 cal yr BP, mixed temperate conifers/broad-leaved forests occupied the landscape of the study area under a cold and dry climate, probably indicating decreased monsoon precipitation. This phase of cold-dry climate and reduced monsoon is globally correlated with the 4.2 ka dry event. Between ~3125 and 1275 cal yr BP (1175 BC-CE 675), under the influence of a comparatively more cold and drier climate, the mixed temperate conifers/broad-leaved forests were transformed into dense mixed temperate conifers/broad-leaved forests around the study area in a regime of more reduced monsoon precipitation, broadly matches with the global Dark Ages Cold Period (DACP; CE 400-765). Subsequently between ~1275 and 774 cal yr BP (CE 675-1176), dense mixed temperate conifers/broad-leaved forests were replaced by mixed temperate broad-leaved/coniferous forests around the study area under a comparatively less cold and dry climate with an ameliorating trend towards a warm temperate humid climate (increased monsoon precipitation). The warm and humid climate of this phase matches well with the Medieval Climate Anomaly (MCA; CE 750-1200) at global level. Finally, between ~774 and 300 cal yr BP (CE 1176-1650), the mixed temperate conifers/broad-leaved forests transformed the mixed temperate broad-leaved/coniferous forests around the landscape of the study area under a cold and dry climate, probably indicating decreased monsoonal precipitation. The deterioration of climate (cold-dry) of this phase is correlatable with the Little Ice Age (LIA; CE 1550-1850).

CP 8.2: Reconstruction of vegetation dynamics and contemporary climate (change) during the Late Holocene from Kumaun Lesser Himalaya.

Md. Firoze Quamar [& Ishfaq Ahmad Mir, Geological Survey of India, Bangalore]

Pollen analysis of a 1.9-m deep lacustrine sediment core, collected from the Honnamannakere Lake in the Karnataka State, Western Ghats, India, has been completed. The pollen evidence indicates that between 731 and 576 cal yr BP (CE 1219-1374), the landscape was dominated by mixed moist/semi-evergreen-dry tropical deciduous forests under a warm and moist climate, possibly indicating increased monsoon rainfall. This phase is globally correlated with

the Medieval Climate Anomaly (MCA; CE 750-1400). Between 576 and 279 cal yr BP (CE 1374-1671), dense mixed moist/semi-evergreen-dry tropical deciduous forests came into existence and transformed the existing forests of the previous phase under a warm and more moist climate with further increase in monsoon rainfall. Finally, between 279 and 8 cal yr BP (CE 1671-1942), mixed moist/semi-evergreen-dry tropical deciduous forests again came into being, replacing the existing dense mixed forests of the previous phase under a warm and comparatively less moist climate with increased monsoon (may be NEM) rainfall, corresponds to the global Little Ice Age (LIA; CE 1550-1850). The hydro-climatic variability during CE 1219-1942 offers valuable insights into the impact of monsoonal variability and human activities on ecosystems in the Western Ghats (India), which are subject to dual monsoon systems (SWM and NEM).

CP 8.3: Species distribution models to predict the potential niche shift and priority conservation areas for mangroves (*Rhizophora apiculata*, *R. mucronata*) in response to climate and sea level fluctuations along coastal India.

Jyoti Srivastava [& Singarasubramanian SR, Department of Earth Sciences, Annamalai University]

We adopted an ensemble modelling approach for the distribution of two mangrove species (*Rhizophora apiculata*, *Rhizophora mucronata*) using high-resolution environmental and edaphic datasets, to identify the PCAs for future conservation. We also identified the key environmental variables shaping their distribution and precisely estimated the core distributional shift along the Indian coastline under changing climate scenario. The findings revealed that about 5844 km² and 7846 km² areas were identified as extremely suitable areas, which were distributed along Maharashtra coast and Kerala coast for *R. mucronata* and *R. apiculata*, respectively, in the current climate scenario. The distribution of *R. apiculata* was found to be mostly shaped by mean diurnal range and annual mean temperature, whereas the distribution of *R. mucronata* was primarily shaped by annual mean temperature and altitude. The highest range expansion of mangrove species occurred during middle Holocene due to high precipitation and sea-level rise and this finding is further supported by fossil pollen evidence. The suitable habitat range for *R. apiculata* is predicted to increase along Kerala coast under RCP2.6 scenario by 6.90% and 6.93% and under RCP8.5 scenario by 9.33% and 9.90% in the year 2050 and 2070, respectively, whereas the range for *R. mucronata* is getting reduced in the future climate scenario. Overall, our predictions reveal a steady migration of conducive mangrove habitat towards land or higher

elevations due to relative sea level rise in future. These results would aid in planning a long-term species-specific conservation and management strategy for mangrove ecosystem along coastal India.

CP 8.4: Assessment of Indian mangroves response to sea-level rise using RSET-MH technique and palynological analysis.

Jyoti Srivastava [& R. Sathyanathan, Associate Professor, Department of Civil Engineering, SRM Institute of Science and Technology, Kattankulathur, Tamil Nadu]

This work marks a significant milestone in establishing the Rod Surface Elevation Table–Marker Horizon (RSET–MH) station, the first of its kind in the Indian mangrove context. The initiative catalyses an in-depth investigation into the response mechanisms exhibited by the Pichavaram mangrove forest, situated in Tamil Nadu, India, near Chidambaram. By meticulously quantifying the intricate dynamics of surface elevation change and vertical accretion, profound insights were garnered concerning the sedimentary processes and the adaptability of mangroves in the face of escalating sea level rise. The bioturbation dynamics will unravel the underlying ecological processes that govern the intricate interplay within the mangrove ecosystem. Furthermore, the determination of plant litter production rates and elucidating leaf litter decomposition patterns for the dominant *Avicennia* and *Rhizophora* species will contribute vital knowledge regarding nutrient cycling and ecosystem productivity.

Palynological analysis was involved to study the historical dynamics of vegetation and the intricate long-term changes that have shaped the present state of the Pichavaram mangrove ecosystem. Significantly, this comprehensive approach has resulted in identifying *Sonneratia griffithii* pollen, previously unreported in the Pichavaram region. These collective findings enhance our understanding of the mangroves' resilience, facilitating the formulation of evidence-based conservation and management strategies. Pollen analysis provided crucial insights into the mangroves' response to sea level rise, aiding in the assessment of their adaptive capacity and guiding targeted measures to mitigate the ongoing environmental challenges effectively. The findings highlight that sites with lower elevation and lower accretion rates are more vulnerable to inundation risks. Bioturbation by crabs was identified as a significant factor influencing sediment accumulation, with variations in crab abundance and activity observed among the sites. The study highlights the significance of litter production as an important parameter influencing vertical accretion in the Pichavaram mangroves. The findings emphasize the need to consider litter production rates and its subsequent decomposition in formulating conservation

and management strategies aimed at sustaining and enhancing vertical accretion processes in the mangrove ecosystem.

CP 8.5. Species Distribution Model (SDM) study.

Anjali Trivedi (& Anjum Farooqui and P. Morthekai, BSIP, Lucknow)]

The analysis has been completed and the preparation of the manuscript is currently underway.

CP 8.6: Phytoliths study from the Bhoj Lake, Bhopal, CMZ of India.

Anjali Trivedi [& Arti Garg, BSI, Prayagraj (Allahabad: BSA)]

The experimental work of 61 grass leaf blades for phytolith has been completed. The writing of the manuscript and the statistical analysis are both now under progress.

OTHER ACADEMIC WORKS

Research Papers presented

1. Halder P, Sharma A, Shukla MK & Kumar K - Unravelling the role of chlorite structure behind the recurring seismicity of an intracratonic region. AGU 23. San Francisco, USA. 11-15th December, 2023. <https://doi.org/10.46427/gold2022.9020>.
2. Halder P, Sharma A, Shukla MK & Kumar K - Can fluid-rock interaction act as a causal phenomenon behind recurring seismicity?: Unravelling the interplay of geochemistry and seismology. Goldschmidt 2022, Lyon, France. 9-14th July 2023. <https://doi.org/10.7185/gold2023.13966>.
3. Halder P, Sharma A, Shukla MK & Kumar K - Is secondary mineralisation playing a pivotal role in recurring seismicity at Koyna-Warna Seismogenic region of India: a geochemical perspective?, EGU General Assembly 2023, Vienna, Austria, 24-28th April, 2023, EGU23-626. <https://doi.org/10.5194/egusphere-egu23-626>.
4. Manoj MC, Crosta X, Shukla SK, Kawsar M & Krishna KA - Ice-rafted debris variability from the western Indian sector of the Southern Ocean over the past 650 ka. National Conference on Polar Sciences (NCPS - 2023), Goa, India. May 2023.
5. Manoj MC, Krishna KA, Crosta X, Shukla SK & Kawsar M - Glacial-interglacial ice-rafted debris variability in the western Indian sector of the Southern Ocean: Palaeoceanographic implications. XXI



INQUA Congress 2023. Rome, Italy. July 2023.

6. Phartiyal B - Cold arid desert of Ladakh, India (geology, landform evolution, climate and neotectonics) at the National Training Workshop palaeoclimate archives-proxies and analysis/measurement techniques (NT-PALEO), IITM, Pune, during 15-26th January, 2023
7. Phartiyal B - Landscape evolution and climatic variations in Ladakh, NW Trans-Himalaya during Late Quaternary at the Conference on Geology: Emerging Methods and Applications (GEM-2023) Christ College, Thrissur, Kerala, 23-25th January, 2023.
8. Phartiyal B - Climatic variations in the last 20 ka in the headwaters of River Indus, Ladakh, India. Conference on Emerging insights on human histories and past environments in India. 6-9th June, 2023, Srinagar, Kashmir co-organised by our institute Birbal Sahni Institute of Palaeosciences, Lucknow, India, Department of Human Genetics, University of Chicago, USA, and Department of Archaeology, University of Kashmir, India.
9. Phartiyal B - Late Quaternary sediment characterisation, neotectonics and climatic record of Ladakh, Northwest Trans-Himalaya, India at the XXI INQUA-2023; 14-20th July, Rome, Italy.
10. Quamar MF - Palynological perspective on understanding climate change in India over the last two millennia: an overview and a critical evaluation. 'Conventional, renewable energy sources and climate change perspective', during June 23-24, 2023 at the Hotel Tuli Imperial, Nagpur, India. (Organised by the Gondwana Geological Society, Nagpur in association with the Geological Survey of India). Abstract Page No. 25.
11. Quamar MF - Vegetation dynamics and hydroclimatic changes since the LGM from the core monsoon zone of India: a multi-proxy approach. XXI Congress of the INQUA 2023. Rome, Italy, during July 14-20, 2023.
12. Quamar MF - Vegetation response to the hydro-climatic changes during the Holocene from the western Himalaya, India: An overview. Reconstructing the human population histories of South Asia using archaeology and genetics', under the umbrella of "Emerging insights on human histories and past environments in South Asia University of Kashmir, Srinagar, India during June 7-9, 2023. Abstract Page No. 37.
13. Samal P, Singarasubramanian SR, Manoj MC, Srivastava J, D'Souza N, Balakrishna K, Chauhan Md M & Ali S - Assessment of heavy metal pollution and human risk in the Mahanadi River sediments, India.

Goldschmidt 2023 Conference. July 2023.

14. Srivastava J - Prediction of potential distribution shift in mangroves in response to climate and sea level changes to target priority conservation areas along the Indian coastline. 1st Indian Conservation Conference (ICCON 2023) in Karnataka State Open University, Mysuru organised by Wildlife Institute of India, Dehradun, April, 2023.
15. Srivastava J - Species distribution models to predict the potential niche shift and priority conservation areas for mangroves (*Rhizophora apiculata*, *R. mucronata*) in response to climate and sea level fluctuations along coastal India. Meeting on the Mangroves of East Coast of India, IISER, Kolkata, August, 2023.

Deputation to Conferences/Seminars/Workshops (both online and offline)

Anupam Sharma, Mukesh Yadav & UK Shukla

- Geochemical and clay mineralogy characterisation of Ganga Flood Plain sediments: Insights to weathering and sediment provenance. XXI INQUA Congress, Rome, Italy. 13-20th July, 2023.

Piyal Halder, Anupam Sharma, Matsyendra Kumar Shukla & Kamlesh Kumar

- Is secondary mineralisation playing a pivotal role in recurring seismicity at Koyna-Warna Seismogenic region of India: a geochemical perspective? EGU General Assembly 2023, Vienna, Austria, 24-28th April, 2023.
- Can fluid-rock interaction act as a causal phenomenon behind recurring seismicity?: Unravelling the interplay of geochemistry and seismology. Goldschmidt 2022, Lyon, France. 9-14th July, 2023.
- Unravelling the role of chlorite structure behind the recurring seismicity of an intracratonic region. AGU 23. San Francisco, USA. 11-15th December, 2023.

Binita Phartiyal

- National Training Workshop Palaeoclimate Archives-Proxies and analysis/measurement techniques (NT-PALEO), IITM, Pune, 15th -26th January, 2023.
- Conference on Geology: Emerging Methods and Applications (GEM-2023) Christ College, Thrissur, Kerala, 23-25th January, 2023.
- Guest Speaker-International Women's Day on 3rd March 2023, SUEZ India, Gurugram..
- LEM-ISS 2023 International School and Symposium, online.



- Conference on Emerging insights on human histories and past environments in India. 6-9th June, 2023, Srinagar, Kashmir.
- Workshop on Water availability & security in Ladakh: past, present, and future scenario, Ladakh University, Leh, 1st April, 2023, Ladakh University, Leh, Ladakh.
- XXI Congress of the INQUA 2023 at the Sapienza University of Rome, Italy, during July 14-20, 2023.

Mohd. Firoze Quamar

- Emerging insights on human histories and past environments in South Asia, University of Kashmir, Srinagar, India, during June 7-9, 2023.
- Conventional, renewable energy sources and climate change perspective', during June 23-24, 2023 at the Hotel Tuli Imperial (Organised by the Gondwana Geological Society and Geological Survey of India), Nagpur, India.
- XXI Congress of the INQUA 2023 at the Sapienza University of Rome, Italy, during July 14-20, 2023.

Anjali Trivedi

- Emerging insights on human histories and past environments in South Asia, University of Kashmir, Srinagar, India, during June 7-9, 2023.
- 7 days hands-on Training program on water resource management at the Geology Department, Lucknow University, Lucknow during 30/05/2023-05/06/2023.

Anjali Trivedi, R Shivanatham, K Ranjan, M Ramesh & Morthekai P

- National Seminar in Commemoration of the centenary celebration of Muthamizh Arignar Kalaignar, 2023, Tamil Nadu State Department of Archaeology.

Manoj MC, KA Krishna, X Crosta, Sunil Kumar Shukla & M Kawsar

- Glacial-interglacial ice-rafted debris variability in the western Indian sector of the Southern Ocean: Palaeoceanographic implications. XXI INQUA Congress 2023. Rome, Italy. July, 2023.
- Ice-rafted debris variability from the western Indian sector of the Southern Ocean over the past 650 ka. National Conference on Polar Sciences (NCPS - 2023), Goa, India. May, 2023.

Jyoti Srivastava

- Meeting on the Mangroves of East Coast of India, IISER, Kolkata, August 2023.
- 1st Indian Conservation Conference (ICCON 2023) in

Karnataka State Open University, Mysuru organized by Wildlife Institute of India, Dehradun April, 2023.

Lectures delivered

Binita Phartital

- Invited talk on International Environment Day 2023 The fragile cryosphere in the present climate scenario: consequences to plastic pollution and biota health, 5th June 2023, Center for Biomedical Research, PGI, Lucknow.
- World Space Week 2023 celebrations, AADYA-Planetary and Geoscience Research 8 October 2023 Role of Geology in Planetary Science.
- Key-note Speaker in the 39th Convention of the Indian Association of Sedimentologists & International Conference, organised by Annamalai University, Tamil Nadu 6-8th December, 2023,
- Master's Course in Astrobiology and Space Sciences : Geosciences-1. Geomorphology; Amity University, Mumbai, 8th December, 2023.
- Interaction programme with CBSE Principals organised by CBSE and Higher education institution (HEI) 14th December, 2023.
- Science Outreach Program under India International Science Festival IISF 2023 "Science and Technology Public Outreach in Amrit Kaal" Curtain raiser of ISSF 2024, 29th December, 2023.
- Invited lecture in the Monsoon lecture series of Professor Peter Clift, LSU Department of Geology & Geophysics, USA, February 8, 2023 online.
- Invited lecture in the lecture series UDAN* in the frame of the UGC and DAAD-funded project Co-PREPARE 24th February, 2023 online.

Jyoti Srivastava

- Mangrove forest dynamics in response to climatic and sea level changes along the Indian coastline. Manipal Institute of Technology, Manipal, on 4th December, 2023.

Trina Bose

- Delivered fieldwork training in sample collecting for dendrochronology, sediment, and other proxies to generate contemporary analogues for palaeoenvironmental reconstruction in tropical dry deciduous forests of western Vidarbha, Maharashtra, India during "Landuse-Landcover mapping and modelling using pollen and isotopic data in different



ecological regions of the monsoon” (LEM) – International School and Symposium (ISS) – 2023, 13-26th March, 2023.

- Lectured on ‘Environmental Isotopes: interpretation and modelling’ and ‘Landcover-Landuse data-integration’ in Prabodhini, Amravati, Maharashtra during LEM – ISS – 2023.

Anurag Kumar

- Delivered talk as a Key-note Speaker at Ultratech Cement Limited, Tanda, District Ambedkar Nagar. Topic: पर्यावरण संवाद जलवायु परिवर्तन व आगामी चुनौतिया 26-28th December, 2023.

Mayank Shekhar

- Delivered talk as Key-note Speaker at Ultratech Cement Limited, Tanda, District Ambedkar Nagar. Topic: पर्यावरण संवाद जलवायु परिवर्तन व आगामी चुनौतिया, 26-28th December, 2023.

Anupam Sharma

- Delivered Lecture entitled “Sediments-an excellent archive for earth surface processes: A case study from the Central Ganga Flood Plain” at Indian Institute of Geomagnetism, New Panvel, Navi Mumbai on February 15, 2024.

Training/Study Visits

Prasanna K & Manoj MC

- Participated in “one week one Lab” campaign of CSIR-CIMFR on 22-26th August, 2023.

Consultancy/Technical Support Rendered

- Samples were analysed under the Geochemical and TL-OSL Laboratory of the Institute. The total consultancy amount during 2023 was Rs. 904467/- only. Apart from consultancy, other in-house project samples were also analysed in the Geochemistry Laboratory.
- Samples were analysed under Clumped Isotope Laboratory of the Institute. The total consultancy amount during 2023 was Rs 28320.00/- Only. Apart from consultancy, other in-house project samples were also analysed in the Geochemistry Laboratory
- Imparted training on the palynology of surface samples from the Udhampur District of the Jammu and Kashmir State (India) was imparted to Mr. Adithya K. M.Sc. (Marine Geology; pursuing), Cochin University of

Science and Technology, Cochin, Kerala during the months of May-June, 2023, which led to his M. Sc. Dissertation.

- Imparted training on the palynology of surface samples from the Jammu region of the Jammu and Kashmir State (India) was imparted to Ms. Suchitra Agrahari, M.Sc. (Applied Geology; pursuing), Department of Geology, Lucknow University, Lucknow during the months of April to June, 2023, which led to her M. Sc. Dissertation.
- Imparted training on the palynology of surface samples from the Mahasamund District of Chhattisgarh State, central India was imparted to Mr. Md. Aftab Ahmad, M.Sc. (Geology; pursuing), Department of Geology, Lucknow University, Lucknow during the months of April to June, 2023, which led to his M. Sc. Dissertation.
- Imparted training on the sediments of upper Jurassic Period under the supervision of Dr Prasanna K, during 17th April to 17th July, 2023 at Birbal Sahni Institute of Palaeosciences, Lucknow. During his dissertation he learned techniques of palaeontology to carry out work on the topic entitled “Insight into upper Jurassic temperature using stable and clumped isotope composition of belemnite” was imparted to Mr. Krishna Pal, M.Sc. student of Department of Chemistry, Lucknow University,

Accolades Received

Binita Phartiyal

- Represented India and won the bid to host INQUA 2027.

Representation in Committees/Boards

Binita Phartiyal

- Editor, Journal of Palaeosciences (www.jpsonline.co.in)
- Member, National Committee for the International Union of Geological Sciences (IUGS) and International Quaternary Research (INQUA) of the Indian National Science Academy (INSA), New Delhi (2024-2026)
- Member, Research Advisory Committee, Wadia Institute of Himalayan Geology, Dehradun (2022-24)
- Expert Member, Subject Expert Committee (SEC) on Earth and Atmospheric Sciences under ‘WISE-KIRAN-Post Doctoral Fellowship (WISE-PDF)’ Program, Department of Science and Technology, India

PH.D. PROGRAMMES

	Priyanka Joshi (2016). Geomorphological evolution and the climatic variations in the ChangLa-Tangste Basin, Ladakh Range, Trans Himalaya, under the supervision of Binita Phartiyal (BSIP) and M. Joshi (BHU), registered with Banaras Hindu University, Varanasi. Status: Awarded.
	Pujarini Samal (2018). Progradation of Mahanadi Delta along Southeast Coast of India, under the supervision of Jyoti Srivastava (BSIP) and SR Singarasubramanian (Annamalai University), registered with Annamalai University, Tamil Nadu. Status: Awarded.
	Shazi Farooqui (2014). Geochemical study of late Quaternary subsurface sediments of lower Mahi River, Gujarat, western India, under the supervision of Anupam Sharma (BSIP) and Munendra Singh (Lucknow University), registered with Lucknow University. Status: Awarded.
	Tarasha Chitkara (2015). Quaternary palaeoclimatic studies using multi-proxy approach around Kurukshetra, Haryana, India, under the supervision of Anupam Sharma (BSIP) and O.P. Thakur, (Kurukshetra University), registered with Kurukshetra University. Status: Submitted.
	Arvind Tewari (2020). Human-climate relationship in the Central Ganga Plain during the Late Quaternary: A multi-proxy approach, under supervision of Binita Phartiyal (BSIP) registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: in progress.
	Harsh Kumar (2019). Role of human-environment interaction in tracing urbanisation in different sectors of Ganga Plain. A geochemical approach, under the supervision of Anupam Sharma (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-Progress.
	Harshita Srivastava (2018). Mineralogical, geochemical and sedimentological aspects of Late Quaternary palaeolake deposits of Ladakh, NW, India, under the supervision of Anupam Sharma (BSIP) and Prof. U.K. Shukla (Banaras Hindu University), registered with Banaras Hindu University, Status: In-progress.
	Ishwar Chand Rahi (2019). Geochemical aspects of lignite bearing deposits of Bikaner and Barmer basins of the western Rajasthan, India, under the supervision of Anupam Sharma (BSIP) and A.S. Naik (Banaras Hindu University), registered with Banaras Hindu University. Status: In-Progress.
	Md. Ikram (2022). Reconstruction of vegetation succession, climate change and human habitation imprints of lacustrine system in the Ganga Plain during Pleistocene-Holocene Period, under the supervision of Anjali Trivedi and Shailesh Agarwal (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Mukesh Yadav (2017). Secondary mineralisation in Central Ganga Plain: implications to climate and earth surface processes, under the supervision of Anupam Sharma (BSIP) and U.K. Shukla (Banaras Hindu University), registered with Banaras Hindu University, Status: In-progress.
	Nagendra Prasad (2020). Reconstruction of Holocene vegetation dynamics and climate change from the core monsoon zone of India, under the supervision of Md. Firoze Quamar (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Piyal Halder (2021). Mineralogical, geochemical and tectonic aspects of Fluid-rock interaction at shallow subsurface level in the Upper Continental Crust in Koyna Seismogenic region, Maharashtra, India, under the supervision of Anupam Sharma and Kamlesh Kumar (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Pooja Saraf (2020). Reconstructing middle Holocene climate and vegetation biomes from fossil pollen data and species distribution modelling in Central Ganga Plain, under the supervision of Jyoti Srivastava (BSIP) and François Munoz (France), registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.



	Prashant Trivedi (2020). Trace element geochemistry of human bones its implication to lithology, dietary habits, geographical location and environmental condition, under the supervision of Kamlesh Kumar and Niraj Rai (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Shirish Verma (2020). Sediment characterisation and palaeoclimatic history of the Karewa deposits, J & K: a multi-proxy approach, under the supervision of Binita Phartiyal (BSIP) and Rakesh Chandra (Ladakh University), registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Supriya Kumari (2018). Palaeolimnology and geochemistry of Quaternary lake sediments deposits from Lucknow to Begusarai transect of Ganga Plain, under the supervision of Kamlesh Kumar (BSIP) and Dhruvsen Singh (Lucknow University), registered with University of Lucknow. Status: In-progress.
	Vijay Rathore (2020). Siwalik sediments: an archive to understand co-evolution of Himalayas and monsoon system using sedimentological and geochemical parameters, under the supervision of Anupam Sharma (BSIP) and U.K. Shukla (BHU), registered with Banaras Hindu University. Status: In Progress.
	Jereem Thampan (2022). Modelling the potential response of natural vegetation to past and future climate change scenarios in Rajasthan, western India, under the supervision of Jyoti Srivastava (BSIP) and Mahesh Sankaran, registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.
	Mohammad Javed (2022). Vegetation and climate change during the Holocene from the central Indian core Monsoon Zone, under the supervision of Md. Firoze Quamar (BSIP) , registered with University of Lucknow, Lucknow. Status: In –Progress.
	Maneesha M ET (2023). Hydroclimate change and corresponding vegetation response from the central Indian Core Monsoon Zone, under supervision of Md. Firoze Quamar (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In –Progress.
	Amal MS (2023). Reconstruction of Arabian Sea coastal upwelling conditions and seawater temperature gradient during Miocene (Burdigalian), India: Insights from stable and clumped isotope analysis of otoliths and molluscan fauna, under the supervision of Prasanna K and Vivesh Vir Kapur (BSIP) , registered with Academy of Scientific & Innovative Research (AcSIR), Ghaziabad. Status: In-progress.

(2021-24)

- Secretary and Founder Member, Association of Quaternary Researchers (AOQR) (2019- 2024)
- Organising General Secretary for INQUA-India, 2027

Srinivas Bikkina

- External PhD Examiner of Ms Pallavi at the IISER, Mohali

Piyal Halder (SRF, MoES)

- Member & Blog Editor - Early Career Researcher (ECR) Committee in Geochemistry, Mineralogy, Volcanology and Petrology (GMPV) Division of the European Geosciences Union (EGU).
- Member, Communication Committee of the European Association of Geochemistry (EAG) for 2024-2026.

FACILITIES

FIELD EMISSION ELECTRON SCANNING MICROSCOPY (FESEM) & EDAX UNIT

The Field Emission Scanning Electron Microscope (FESEM) equipment, equipped with Field FESEM - JEOL 7610F, allows researchers to analyse their specimens in order to examine surface morphological aspects. The facility enables researchers to investigate the topography of materials at high resolution, allowing them to understand the ultrastructures of objects up to the nano scale, which is not achievable with optical microscopy.

The facility also conducts elemental analysis of their samples during the FESEM observation. EDAX uses a peltier-cooled EDS spectroscopic detector and a microphotograph to aid them characterise their specimens. The unit supports frontline research in the Palaeosciences, Geology, Biology, and Materials Science, among other areas, for the Institute's scientists and research scholars.

Several scientists at the institute and research scholars used the FESEM and EDAX facilities to analyse materials from numerous fields. Despite the Institute's scientific activity, the FESEM facility has also been made available to researchers from other Indian universities, academic institutions, and colleges in their spare time. The rendering

consultation not only provides a source of cash for the institute, but it also aids in the dissemination of its specialised knowledge and publicity.

- University of Lucknow, Lucknow (Nano materials, powder, Insects)
- Career PG Institute of Dental Sciences and Hospital, Lucknow (Tooth samples)
- CSIR-NBRI, Lucknow (Rice, Leaf)
- Hygia Institute of Pharmacy, Sitapur- Hardoi bypass Road, Lucknow (Pharmaceutical samples)
- University of Allahabad, Prayagraj ,UP (Powder Sample)
- AcSIR, CSIR-CIMFR, Dhanbad, Jharkhand (Charcoal)
- Alakh Prakash Goyal Shimla University, Shimla, Himachal Pradesh (Powder Samples)
- Govt Degree College Hansaur, Barabanki, UP (Powder Sample)

Total consultancy money received around Rs. 277645/= (Two Lakh seventy seven thousand six hundred forty five).



SEM / CLSM Committee: **L to R:** Shivalee Srivastava, Vartika Singh, Hukam Singh, Subodh Kumar



CONFOCAL LASER SCANNING MICROSCOPE AND RAMAN SPECTROSCOPY LABORATORY

Confocal Laser Scanning Microscope (CLSM) has demonstrated its value in creating 3-D pictures of fossil material from specimens that are typically 2-D. When determining the structure and functions of the many fossilised species, three-dimensional reconstructions reveal important characteristics of the microfossils. The inherent capability of CLSM to optically segment light allows for precise, high-resolution, and high-contrast reconstructions of 3D structures. This is accomplished by capturing a series of images at different depths and subsequently combining them to generate an accurate representation.

Raman Spectroscopy has been instrumental in promoting scientific investigation and analysis. The laboratory has been at the forefront of using cutting-edge equipment and skills to investigate molecular structures, chemical compositions, and material characteristics. The Raman Spectroscopy continues to make a substantial contribution to our knowledge of complex systems and to the facilitation of ground-breaking discoveries by offering accurate molecular fingerprinting and characterisation.

At our institute, 131 specimens have been processed using CLSM, and 168 sample points have undergone Raman

Spectroscopy analysis. Scientists from various disciplines have utilised these techniques to investigate morphological features and perform chemical analysis on their respective samples. The CLSM and Raman Spectroscopy facility not only provides internal research requirements but also extends its services to external academic institutions, including consultancy services for researchers from various universities and academic institutions across India.

During the 2023-24 period, students and researchers from different institutions, including BSIP, the National Institute for Pharmaceutical Education and Research, and Raebareli, utilized our Institute's CLSM and Raman Spectroscopy facility for their studies. Various institutions recognised the value of our facility in their respective fields of study, highlighting the broad applicability and interdisciplinary nature of CLSM and Raman Spectroscopy in advancing research across biosciences, dental sciences, and medical disciplines.

The total consultancy generated during 2023-2024 amounted to Rs. 15340/- (Rupees Fifteen thousand three hundred and forty only).

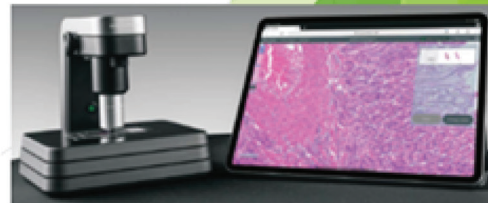
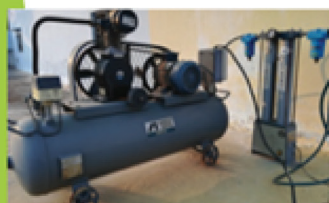
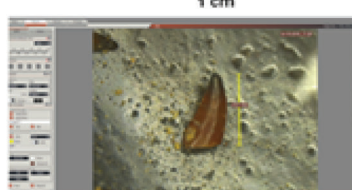
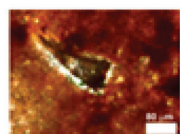
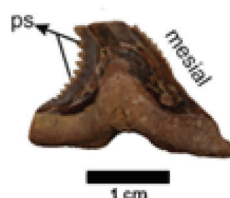


VERTEBRATE PALAEONTOLOGY AND PREPARATION LABORATORY

The Institute's "Vertebrate Palaeontology and Preparation Laboratory" (VPPL) was founded in 2018 and has been operating efficiently ever since. Its purpose is to prepare and analyse fossil vertebrates, related microfauna, and ichnofossils (such as coprolites). The facility has a dual tank sandblaster equipment and an electrically operated, 100% oil-free air compressor with pressure regulators that assist in running the pneumatic air scribes. The sandblaster unit and the pneumatic air-scribes both help with the processing of fossil remains. Additionally, the lab is furnished with a stereoscopic microscope to aid in the extraction of microfossils from the host matrix and

an ultrasonic cleaner for cleaning micro-fossils (such as dental remains). The lab is additionally furnished with technology and software for measuring (manually and digitally), taking pictures, documenting, and researching (morphometrically and phylogenetically) vertebrate fossils. Furthermore, an automated slide scanner for real-time microscopic examination and digital preservation of thin section slides of fossils and related ichnofauna is available at the VPPL facility. Apart from using worldwide standards for dust, eye, and ear protection, preparation work is done under a specially designed dust collector safety box in compliance with health and safety measures.

कशेरुकी जीवाश्म विज्ञान एवं प्रसंस्करण प्रयोगशाला Vertebrate Palaeontology And Preparation Laboratory





INDUSTRIAL MICROPALAEONTOLOGY LABORATORY

The Industrial Micropalaeontology Laboratory at the Birbal Sahni Institute of Palaeosciences was inaugurated in January 2022 and is fully dedicated to the analysis of palynological and palaeontological proxies for application in hydrocarbon exploration. Major functions of this facility include precise age determination through biostratigraphy and preparation of 2D depositional palaeoenvironmental models based on the analysis of foraminifera, calcareous nannofossils, dinoflagellate cysts and spore-pollen.

Calculation of Palynological Marine Index (PMI) for deciphering sea level changes, identification of marine flooding surfaces, and the demarcation of palaeoshorelines and preparation of ecological charts are some of the other deliverables from the study of palynological proxies. Study of benthic and planktic foraminifera are an integral component of the laboratory work that have high potential in the reconstruction of shallow-marine

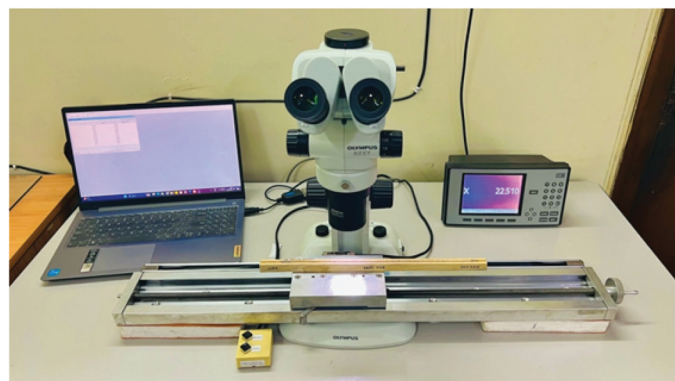
to deeper palaeoenvironments and deducing valuable palaeobathymetric data.

The laboratory facilities include several sophisticated microscopes like Leica M205 C stereo microscope, Leica DM3000 LED light microscope and Leica DM2500 polarizing microscope with all the necessary camera attachments. The lab is equipped with other minor instruments such as multiple hot air ovens, distilled water unit, ultrasonicator cleaners and weighing machine. In 2022-23, under the BSIP-ONGC RGL Vadodara project entitled 'Palaeobathymetric variations through time from middle to late Eocene and reconstruction of Palaeogeographic Maps of Cambay Basin', 538 well cutting samples from 23 wells (Cambay Basin) were studied for foraminifera, calcareous nannofossil, dinoflagellate cysts and spore-pollen in the Industrial Micropalaeontology Laboratory being the fulcrum of the project.



DENDROCHRONOLOGY LABORATORY

The dendrochronology laboratory facility of the BSIP deals with the dating and study of the annual growth increments, or tree rings, in woody trees and shrubs. This lab focuses on methods of dendrochronology in both conifers and broad-leaved taxa to build high-resolution tree-ring chronologies of past events from various regions of India. These past events mainly include spatio-temporal climate (temperature and precipitation), droughts, streamflow, glacial history, and vegetation index reconstruction beyond the existing instrumental data.



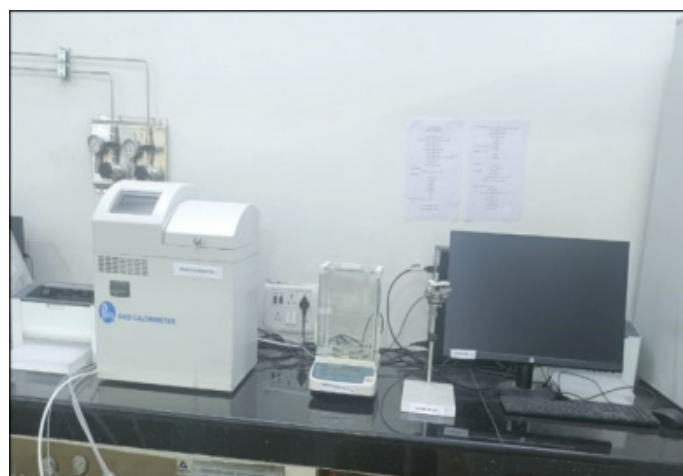
The unit is equipped with tree-ring sample processing. The Laboratory currently houses a Velmex Measuring Machine, a Lintab Measuring Tool connected to a Stereozoom Microscope, and a computer system. The Dendrochronology Group has expertise in applying advanced statistical analysis to tree-ring data.

COAL UNIT

The Coal lab at BSIP is equipped with state-of-the-art facilities for coal characterisation. Operating as a core facility, it provides analytical services and expert advice to researchers and external users from academic, government, and industrial backgrounds on a payment basis. Established in 2023, the unit integrated the existing coal petrology lab and FTIR lab into this unit. Since

then, it has expanded significantly with the acquisition of various sophisticated analytical instruments such as Bomb Calorimeter (2 Numbers), Thermo Gravimetric Analysers (2 Numbers) and a CHNS-O Analyser. In the last financial year, the following instruments were installed under the geochemistry unit:

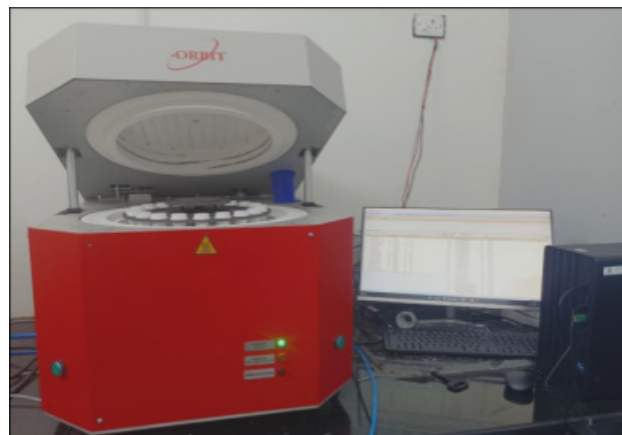
- 1) **Model Name: Bomb Calorimeter (Parr 6400):** The Parr Bomb Calorimeter is a useful tool to analyse the Gross Calorific Value (GCV) of coal. The Bomb Calorimeter gives the classification for the grade/rank of the coal. This gives the heat of combustion or calorific value of materials which are burned as fuels that include utilisation of solid and liquid fuels, disposal of combustible wastes, study of foods and feeds.





- 2) **Model Name: Thermo Gravimetric Analyser (Orbit 3000):** The Thermo Gravimetric Analyser (TGA) 3000 is a useful tool to analyse the percentage of moisture, volatile matter, and ash content of any organic-rich sediments. TGA 3000 also helps in grading the quality of the coal for industrial uses for various purposes.
- 3) **Elementar Vario Macro Cube Elemental (CHNS-O) Analyser:** Fully automatic computer-controlled rapid determination of Carbon, Hydrogen, Nitrogen, Sulphur and Oxygen analysis in coal/coke samples. Flash combustion design with oxidation & reduction process (Double Furnace) with Chromatographic separation by column or equivalent system. The analysis complies with ASTM D5373 and ASTM D4239. The system is equipped with a single autosampler with 60 samples capability for CHNS-O for both solid and liquid samples.
- 4) **Coal Petrography Microscope:** In coal petrography, study the organic constituents specially called as macerals and classify the coal components. The maceral identification was conducted in oil immersion under incident white light and UV excitation. Here, we use a Leica DM 4 P organic-petrography microscope 50x through this we find the macerals and measure the reflectance by the help of Vitrinite Reflectance unit and determine the rank of coal. For the analysis of coal samples, prepare the pellets via crushing, sieving, embedding, grinding, and polishing.
- 5) **FTIR:** Fourier-Transform Infrared Spectroscopy identifies the organic, polymeric and inorganic materials by the use of infrared light to scan the sample and observe the chemical properties, chemical bonds in molecules, functional group as well as mineral matter and its abundance. In FT-IR analysis, we use three units depending on requirements: ATR (Attenuated total reflectance), KBr, and microscopic-based unit.

The facility significantly enhanced the analytical capabilities of the institute and many scientists are benefitted since it become functional. Besides, it also attracted consultancy services in its short span and earned a sum of Rs. 90,978/- in the year. The major organisation used the facility are CIMFR, Dhanbad; Mizoram University; Lucknow University; IIT ISM, Dhanbad; IIT, Roorkee; CPGIDMS, Lucknow.



TL/OSL AND GEOCHEMISTRY UNIT



Sitting (L-R): Dr. P. Morthekai, Mr. Shivam Yadav, Dr. Anupam Sharma (Lab in-charge), Mr. Ashik, Mr. Gurusevak, Mr. Ravishankar
Standing (L-R): Dr. Anurag Kumar, Dr. S Nawaz Ali, Dr. Prasanna K, Mr. Jitendra Yadav, Mr. Ankit Pratap Singh, Dr. Amritpal Singh Chaddha, Dr. Kamlesh Kumar, Mr. Ishwar Chandra Rahi, Dr. Pawan Govil, Dr. Nitesh Khonde, Dr. GP Gurumurthy, Dr. Trina Bose, Mr. Faizan Khan, Mr. Kishore Katange, Dr. Manoj MC, Dr. Runcie Paul Mathews

The TL/OSL and Geochemistry Unit at the Birbal Sahn Institute of Palaeosciences (BSIP) is equipped with state-of-the-art facilities designed to support a wide array of luminescence and geochemical studies. Functioning as a core facility, it offers comprehensive analytical services and expert guidance to researchers, academicians, government entities, and industrial clients on a fee-for-service basis. Established in 2014, the unit initially focused on developing a wet chemistry laboratory dedicated to sample processing. Over the years, it has seen substantial growth, both in infrastructure and capabilities, with the acquisition of advanced analytical instruments. The unit is now equipped with several sophisticated tools, such as Isotope Ratio Mass Spectrometers (IRMS) (MAT 253, Delta Q, Delta V Advantage, and MAT 253 Plus), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES), X-Ray

Diffraction (XRD), X-Ray Fluorescence (XRF), Thermo Luminescence/Optically Stimulated Luminescence (TL/OSL) readers, High-Purity Germanium (HPGe) detectors, Laser Diffraction Particle Size Analyzers (LPSA), Spectrophotometers, portable water quality analyzers (WTW and Hanna), and a Nutrient Analyser (SKYLAR).

In a recent development, the laboratory has also established a sediment core storage and cutting facility, further enhancing its capacity to support extensive geochemical and palaeoclimate research. This expansion underscores the unit's commitment to providing cutting-edge analytical services and fostering scientific advancement across multiple disciplines.

Consultancy Services: The unit facilitated the services using different instruments such as TL/OSL, IRMS,



Sediment Core Storage Cutting Facility



Core Splitting



Cold Storage



Core Cutting and analysis Facility

XRD, XRF, ICP-MS, ICP-OES, Grain Size Analysis (LPSA), Nutrient Analyser, Soil/Water Analysis, UV-VIS Spectrophotometer to various organisations and received

INR 21,65,887.00 as total consultancy amount for the year 2023-24.

PALAEOMAGNETISM LABORATORY



L to R: Arvind Tewari, Sarvendra P Singh, Binita Phartiyal, Prasanta K Das, Mohd Arif, Shirish Verma

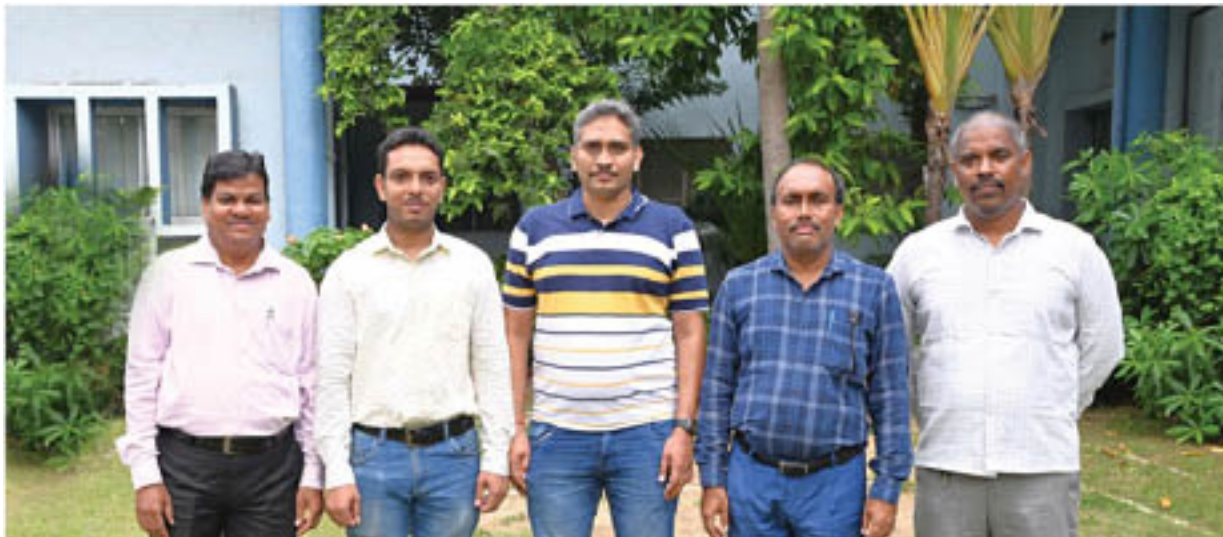
The Palaeomagnetism Laboratory of the Institute at present grows to a national facility and hosts a range of instruments *viz* the complete Bartington Susceptibility meter (MS2B) and sensors for *insitu* and laboratory analysis, the MFK2-FA Kappabridge (AGICO), JR-6 Spinner Magnetometer (AGICO), IM-10-30 Impulse Magnetiser (ASC Scientific), D2000-T AF Demagnetiser (ASC Scientific), TD-48 Thermal Specimen Demagnetiser (ASC Scientific). This year the MFK2-FA Kappabridge is upgraded with CS-4 and CS-L temperature sensors for analysis of magnetic mineral phases in rock/sediment samples from Liquid Nitrogen to 700°C. The lab also hosts sample preparation tools like the Pomeroy Rock drill, Dual Blade Rock Saw, Laboratory

Lapidary Core Drill for complete palaeomagnetic, rock and environmental magnetic characterisation of range of sample types like rocks, sediments, soils, dusts and leaves. During the year 2023-24, the laboratory analyses a total of 2375 samples with a total 27748 analysis of magnetic proxies of 18 different researchers across the country for various scientific objectives. The laboratory also provides consultancy services to industries, universities and other stakeholders and helps in resource generation. The lab imparted summer internship and dissertation training to 6 Masters and Bachelors students of various universities in the year 2023.



Fig. A. Kappabridge; B Alternating Field Demagnetiser; C. Impulse magnetiser; D. Magnetometer

RADIOCHRONOLOGY AND ISOTOPIC CHARACTERIZATION LABORATORY



(L to R): Deepak Kumar, SKS Gahlaud, Srinivas Bikkina, Dharendra K Pal, J Bhaskaran

Radiocarbon dating facility of Birbal Sahni Institute of Palaeosciences continues to serve as a National facility catering variety of researchers across India and abroad. Recently, the lab has been upgraded with newer and advanced techniques which comprises of two components (a) Radiochronology using the radiocarbon measurement and (b) stable isotopic ratio measurement using (EA-IRMS). The laboratory specializes in radiocarbon measurement of various types of geological and archaeological samples where sample size varies from kilos to milligrams. Our conventional Radiocarbon dating facility utilizes an offline glass vacuum benzene preparation system and an ultra-low-level Liquid Scintillation Counter (Quantulus; Wallac 1220®) for bulk geological samples. The other upgraded facility utilizes very small size sample, which is processed through an automated graphitization unit (AGE, IONPLUS®) coupled with sample preparatory systems such as Elemental Analyzer (Elementar®), Carbonate Handling System (CHS; IONPLUS®) and an in-line Isotope Ratio Mass-Spectrometer (IRMS) for quality assurance through measurement of stable carbon and nitrogen isotopes ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$). Samples for C-14 dating are received via both ways i.e. through institutional and collaborative scientists via institutional and sponsored projects. The facility also receives external samples for dating from external agencies on payment basis. Using this new setup, several newer type of samples were dated such as horse and human teeth-enamel, collagen extracted from

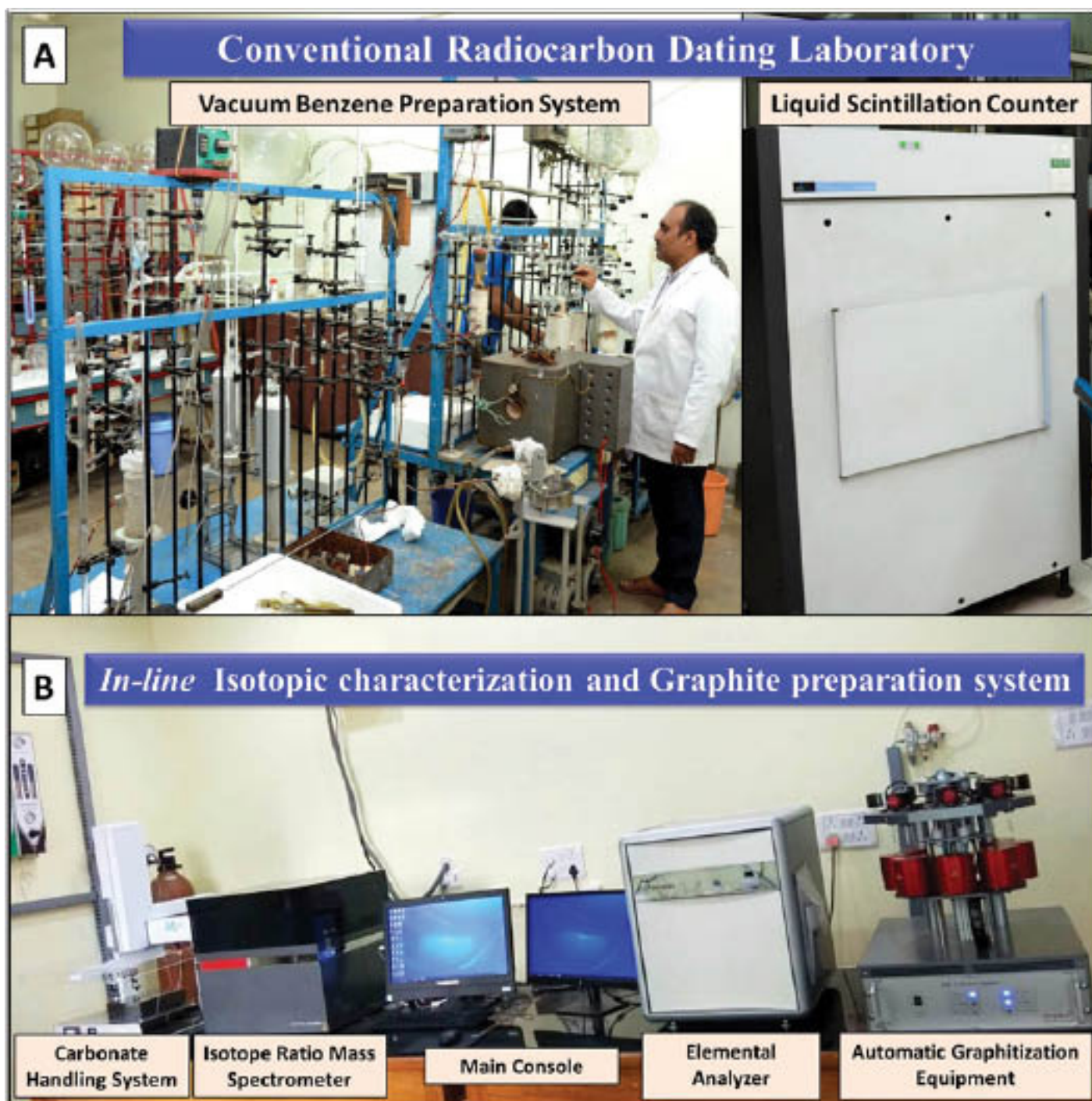
human burials, wood-cellulose, and charred agricultural grains. This upgraded set up has enhanced the range of samples that could be dated which has increased the sample flow from all over the India.

Stable isotope measurement unit of the laboratory has continued to advance its capabilities in measuring stable carbon, nitrogen, and sulfur isotopes throughout 2023. This facility provides

diverse range of scientific studies, such as biogeochemical cycling, palaeoclimate interpretation, environmental science, archaeology, and biogeochemistry.

In this year, we have analyzed stable isotopic ratios ($\delta^{13}\text{C}$, $\delta^{15}\text{N}$ and $\delta^{34}\text{S}$) of ~1800 samples from terrestrial organic/ marine sediment/ Archaeological samples from In-house projects and several Government Institutes/Private Industries. We have prepared ~85 graphite of In-house projects and other Government/Private institutes and Industries.

We have earned consultancy of amount 744,000/- INR for the year 2023-2024. Major government clients are from the GSI-Raipur, GSI-Bhubaneswar, GSI-Bangalore, GSI-Hyderabad, GSI-Lucknow, GSI-Jaipur, Bihar Heritage Development Society-Patna, GSI-Kolkata, Kumaun University-Uttarakhand and several private industries.



UNITS

MUSEUM

Museums are vital in geological Science, preserving invaluable specimens and fostering education and research by showcasing Earth's geological history and biodiversity. They offer visitors an engaging way to explore the planet's past, sparking curiosity and appreciation for the natural world. The BSIP Museum disseminates knowledge about Palaeosciences through videos, posters, pamphlets, and outreach activities. It exhibits in spacious halls cover various aspects of Palaeosciences from basic and advanced perspectives. Museum often participates in science festivals, Expo, outreach activities and also organises in-house programs to promote fossil awareness and scientific knowledge.

Museum participated in the 6th Bharatiya Vigyan Sammelan (BVS) and Expo, jointly organised by Vijnana Bharati (VIBHA) and the Government of Gujarat at Ahmedabad from 21st to 24th December 2023. The focal theme of Sammelan was "भारत का विकास भारतीय मूल्यों और नव प्रवर्तन के साथ": A New Integral Vision for Development". BVS 2023 was organised to provide an excellent platform to integrate and showcase our Indian traditional practices, grassroots innovations, common people's contributions to Science, and the scientific contributions of researchers and scientists in contemporary Science. The BSIP stall, featuring numerous



fossils, also attracted the attention of the honourable Chief Minister of Gujarat, Shri Bhupendrabhai Patel.



Museum also participated in the 9th "India International Science Festival" (IISF-2023) held in Faridabad, Haryana, from 17th to 20th January 2024. IISF is the largest science festival in India, organised by the Department of Science and Technology (DST), aimed to connect all societal segments under the theme "Science and Technology Public Outreach in Amrit Kaal." The BSIP showcased fossils and exhibits, inspiring scientific enthusiasm among students and promoting scientific temper. The event saw participation from representatives of 22 countries. The presence of distinguished guests graced the BSIP stall at the festival: honourable Union Minister of State for Science & Technology, Dr Jitendra Singh, the honorable Chief Minister of Haryana, Shri Manohar Lal Khattar, the Secretary for the Department of Science and Technology (DST), Prof. Abhay Karandikar, and the Secretary for the Department of Space and Chairman of ISRO, Shri S. Somnath. These dignitaries showed keen interest in the fossils and exhibits, engaging with the BSIP staff. On National Science Day (NSD), celebrated annually on 28th February to commemorate Sir C.V. Raman's Nobel



Prize-winning discovery of the 'Raman Effect', the BSIP Museum conducted outreach activities for the students and faculty from multiple schools and colleges. Established by the Indian government in 1986, NSD promotes science activities nationwide, especially in educational institutions. The 2024 theme, "Indigenous Technologies for Viksit Bharat," was announced by Dr. Jitendra Singh, Union Minister of State for Science & Technology. Nearly 150 students participated in these activities, with BSIP

staff also visiting various institutions to promote the event.

In the fiscal year 2023-24, the BSIP Museum's repository acquired research materials, including plant megafossils and palynological samples from 211 localities across India. Additionally, type materials for 10 research papers were submitted to the repository. The description of the repository is as follows:

Museum Holdings:

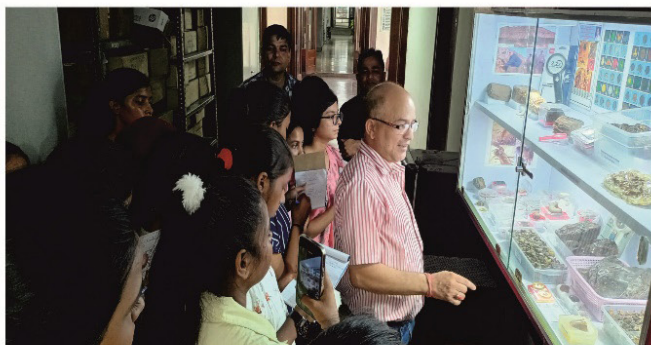
Particulars	Addition during 2023-24	Totals
Type and Figured Specimens	83	9,809
Type and Figured Slides	93	16,636

Specimens/ Samples collected by the Scientists during the field work under various projects:

Project	Megafossil Specimens	Palynological Samples
Project-1	.....	17
Project-2	208	870
Project-3	364	491
Project-4	.....	.....
Project-5	.....	909
Project-6	.....	252
Project-7	.....	121
Project-8	.....	490

Samples deposited in the repository under Sponsored/ Collaborative Projects:

Sr. No.	Projects	Samples/ Specimens
1	SRG 22/220841	22- Samples
2	CRG/2019/002204	204-Samples
3	CRG/2019/002461	23- Samples, 61 Specimens
4	ONGC Sponsored Project	33- Samples
5	CRG/2022/003341	06-Samples
6	CRG/2022/00460	138-Samples
7	LEM-1304 (INQUA)	157- Samples
8	ONGC Sponsored Project	125- Samples
9	EEQ/2021/000846	153- Samples
10	EEQ/2021/000787	103- Samples



Institutional Visitors:

1. Acharya Narendra Deo Kisan P.G. College Babhnan, Gonda, U.P.
2. Bharatiya Mahila Gramodyog Sansthan, Prayagraj, U.P.
3. Chinmaya Vidyalaya NTPC, Unchahar, Raebareli, U.P.
4. Dayanand Post Graduate College, Bachhrawan, Raebareli, U.P.
5. Department of Botany, Arya Vidyapeeth College, Guwahati, Assam
6. Dr. Rajendra Prasad Memorial Degree College, Rajajipuram, Lucknow, U.P.
7. Govt. Girls Inter College, Gilauli, Pandri Kripal, Gonda. U.P.
8. Greenland Public School, Vijayant Khand, Gomti Nagar, Lucknow, U.P.
9. K.N. Govt. P.G. College, Gyanpur, Bhadohi, U.P.
10. Mahamaya Govt. Degree College, Mahona, Lucknow, U.P.
11. Maharishi University of Information Technology, Lucknow, U.P.
12. Pandit Deen Dayal Upadhyay Govt. P.G. College, Sitapur, U.P.
13. PBRP Academy Muradganj, Auraiya, U.P.
14. Sri Ramswaroop Memorial University, Lucknow, U.P.
15. Techno Institute of Higher Studies, Lucknow, U.P.



COMPUTER SECTION

Official E-Mail accounts for BSIP Staff, units/sections and AcSIR fellow/research scholars have on BSIP Domain (bsip.res.in). Institute Facebook page and Twitter account has been created and regularly updated the with the latest scientific information and scientific events with photographs. Video Conferencing System is also installed in Committee Room and online interview, video conferencing through G-meet, Team, Webx, etc. are also arranged as and when required. For internal file movement, File Tracking System (FTS) has been successfully implemented. Now the location of the file can be known anytime from anywhere. Circular/Notices are circulated to everyone through Mail and WhatsApp Group.

This year New Wi-Fi zone has been created with 20 new Access Point. Now speed of Internet connectivity is up to the mark. Computer Section is maintaining NKN (National Knowledge Network) Internet connectivity in the Institute to provide 24 hours high speed Internet facility to the Institute employees and research scholars. All the systems (around 199) are protected from viruses and worms by Anti Virus Program (Quick Heal Endpoint Security 9.0 Business edition). Institute is fully covered

with Wi-Fi and staff members are using Wi-Fi connectivity on their mobile also. For Network security Sophos - XG-230 firewall is working. This year Computer Section has procured the Dell Server PowerEdge R 750xs/01.

Redesigning of the Institute's Website is done as per GIGW norms. Scientists can update their work and achievements on their webpage with more reach in the public. Computer Section is maintaining and updating the Institute's Website (www.bsip.res.in) regularly. Various utility forms are converted into bilingual and uploaded in PDF and Word format so that anyone can download and use them. Intranet website has also been launched for Institute users/research scholars.

In addition, web based payroll, pension packages also developed and modified as per the requirements of the Account Section, Employees are receiving the pay slip by email. Computer Section is providing help to the scientists in preparing the multimedia presentations, charts, graphs, litho logs and diagrams for their scientific publications and documentation. Technical Assistance for Computer is also provided to every staff and units to ease their work.



L to R: Pavan S. Katiyar, Yogendra P. Singh,
Ajay K. Srivastava, Nilay Govind



KNOWLEDGE RESOURCE CENTRE

The Knowledge Resource Centre (KRC) is committed in providing the best information services and support to its users and fulfilling its mission to disseminate knowledge.

The current holdings of the library are as under:

Particulars	Additions during 2023-24	Total
Books in English	4	6,423
Journals (bound volumes)	65	18,097
Reprints	-	40,179
Reference Books	-	356
Books in Hindi	41	943
Ph.D. Thesis	1	149
Reports	-	46
Maps & Atlas	-	61
Microfilm/ Fisches	-	294
Compact Disk	-	74

(Working hours 9.30-18.00 Mon-Fri)

Currently the KRC is receiving 130 journals (34 through subscription, 56 through NKRC and 40 through exchange). There are 185 registered card holders using the KRC facilities.

Many other institutions / organizations availed the KRC facilities.

In addition, online access of e-journals and databases (viz. Scopus, Web of Science) is available over the Institute's LAN. KRC also provides plagiarism check of manuscripts through iThenticate software, reprography, weekly current awareness and daily local newspapers for reading.



1st Row (L to R): Veeru K Singh, Binita Phartiyal, Sheikh N Ali; **2nd Row (L to R):** Bhawana Awasthi, Indra Kumar, Nandita Tewari, Sumit Bisht, Dharendra Sharma, Niteshkumar Khonde



PUBLICATION



1st Row (L-R): Shivali Srivastava, Syed Rashid Ali, Suman Sarkar, Rattan Lal Mehra, Swati Tripathi; **2nd Row (L-R):** Sumit Bisht, Prasanna K., Mahesh G. Thakkar, Binita Phartiyal, Deepa Agnihotri

Journal

The Institute's flagship journal, Journal of Palaeosciences (formerly The Palaeobotanist), continues its legacy as a premier publication in the field. With a rich legacy dating back to its inception in 1952, the journal underwent a significant transformation in 2021, symbolizing its evolution to encompass a broader spectrum of research interests.

The Journal of Palaeosciences remains steadfast in its commitment to fostering open access and facilitating the dissemination of groundbreaking research. Its purview spans a diverse array of disciplines, including palaeo-environmental studies, palaeoecology, palaeoclimatology, and palaeogeography, covering geological time scales ranging from the pre-Cambrian to the Quaternary Period. In order to keep up with the rapid advancement of technology, the Journal of Palaeosciences has switched to an online platform. The journal's website is www.jpsonline.co.in. Moreover, the publication unit diligently

managed the correspondence related to journal operations, further enhancing its scholarly outreach.

Volume 71 of the journal, published in 2023, comprising two issues, this volume featured a total of 11 research papers and 6 reports, each contributing to the advancement of knowledge in the field of palaeosciences.

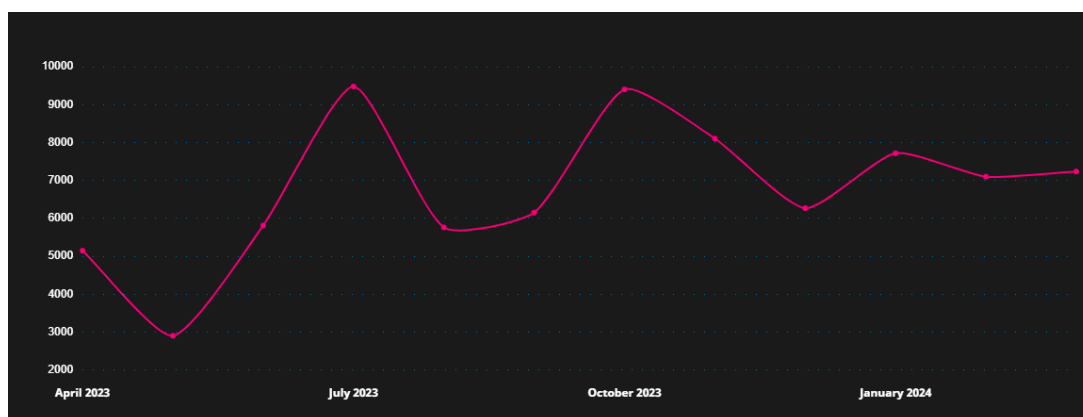
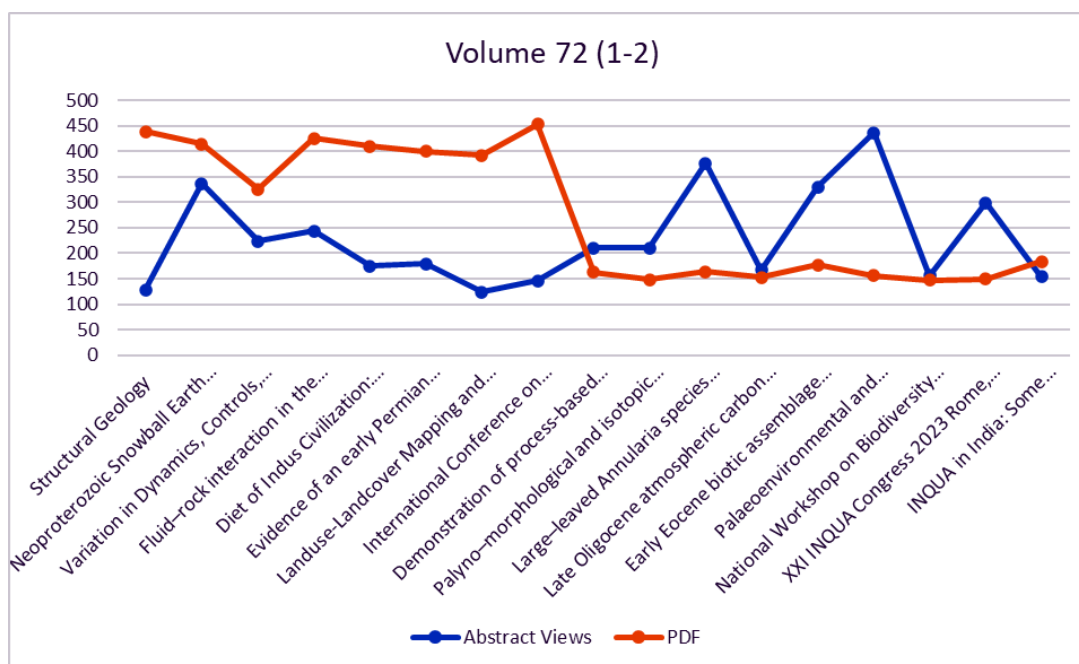
Annual Report

Bilingual Annual Report of the Institute was published in Hindi and English containing relevant information related to research work carried out in the Institute under different research projects during the period of 1st April, 2023 to 31st March 2024. This comprehensive report detailed research projects, conference participations, awards, publications, training initiatives, Foundation/Founder's Day celebrations, unit reports, financial summaries and other pertinent aspects, supplemented by graphical representations and photographic documentation.

Miscellaneous

In addition to scholarly pursuits, the publication unit actively engaged in organisational activities, including the printing of invitation cards for Foundation Day, Founder's

Day and Conferences. Biographical profiles and abstracts of lectures given by eminent speakers on various functions were printed.



Number of times research papers were downloaded (April, 2023-March, 2024).



STATUS OF IMPLEMENTATION OF RAJBHASHA HINDI



L to R: Neelam, Swati Tripathi, Poonam Verma, Mahesh G Thakkar, Sandeep K Shivhare, Mishri Lal, Ashok Kumar, Manoj MC, Pavan S. Katiyar

The Institute continues to endeavor to follow the policy and guidelines of Rajbhasha Vibhag, Home Ministry, India and regularly submitting its quarterly and half-yearly progress report to Rajbhasha Vibhag, Department of Science and Technology, New Delhi. The Institute also participated in both the Half Yearly meetings of the Town Official Language Implementation Committee (TOLIC-3) during the year 2023 at Indian Institute of Sugarcane Research, Lucknow. Implementation of Rajbhasha Hindi in the Institute is being monitored by Rajbhasha Implementation Committee of BSIP. The committee monitors and plans for progressive increment in the implementation of Hindi. The committee takes cognizance of the progress in the Hindi implementation through its regularly organised quarterly meetings. In order to promote use of Hindi as Rajbhasha in official activities and mutual communication in office, the committee organises various activities such as Hindi Pakhwada, quarterly technical as well as science lectures in BSIP, outreach activities preferred in Hindi and interactions during field works/workshops/exhibitions in various institutions/forums. The scientists and technical officers and other employees of the Institute also took active part in promotion of communication in Hindi on scientific, technical and administrative level.

Hindi Fortnight

This year under the banner of the Rajbhasha Implementation Committee, Institute celebrated Hindi Pakhwara during September 14-29, 2023. It was inaugurated on 14th September 2023 by Prof. Dhruv Sen Singh, Lucknow University with his inaugural address. During the fortnight, competitions, namely Debate, Hindi Typing, Hindi Translation, Hindi Noting, Dictation (for MTS only), Essay, Poster, Antyaaksharee and Kavi Sammelan were organised.

Hindi Quarterly Workshops:

1. “Cenozoic paraganuvigyan: parichay evam anuprayog” by Dr. Poonam Vema, Scientist ‘E’, BSIP on 19th June, 2023.
2. “Jalvayyu parivartan: prakritik ya manavjanit” by Prof. Dhruv Sen Singh, University of Lucknow, Lucknow on 14th September, 2024.
3. “Rajbhasha Prabandhan” by Mr. Chandra Mohan Tiwari, Retired Hindi Officer, CSIR-IITR, Lucknow on 27th December, 2023.

Competition	No. of participants	First Prize	Second Prize	Third Prize	Consolation Prize-1	Consolation Prize-2
Hindi Typing (computer)	6	Mrs Sudha Kureel	Mr Abhay Shukla	Ms Barsha Shah	Mr Shakti Verma	Mr Purneshwar Prakash Mishra
Hindi Noting	11	Mr Rahul Gupta	Ms Barsha Shah & Mrs Sandhya Mishra	Mrs Sudha Kureel	Mr Abhay Shukla	Mr Shirish Verma
Hindi Translation	11	Mrs Sandhya Mishra	Mr Abhishek Sachan	Ms Barsha Shah	Mr Shirish Verma	
Debate in Hindi	14	Ms Sneha & Mr Prashant Mohan Trivedi	Ms Vartika Singh	Mr Sarvendra Pratap Singh	Mr Sadanand Pathak	
Dictation (for MTS Staff)	8	Mrs Bhawna Awasthi	Mr Puneet Pandey	Mr Shivam Yadav	Mrs Sandhya Singh	Mr Akeel Siddiqui
Essay Writing	13	Mrs Sandhya Singh	Mr Anand Rajoriya	Ms Ruchita Yadav & Mr Brijesh Kumar Yadav	Mr Sarvendra Pratap Singh	
Poster	15	Mr Anand Rajoriya	Mr Deveshwar Prakash Mishra	Ms Ruchita Yadav	Ms Ayushi Mishra	Mr Yogesh Pal Singh
Antyaaksharee	18	Mrs Sandhya Mishra, Mrs Sandhya Singh & Ms Diksha	Mr Arvind Tiwari, Mr Brijesh Kumar Yadav & Mr Shirish Verma	Ms Vartika Singh, Ms Pujarini Samal & Mrs Parul Dutt Saxena		



Photographs during various competitions during Hindi Fortnight-2023



Photographs during various Hindi Quarterly workshops at BSIP

4. “Jalwayu parivartan anusandhan mein vriksh valay (Tree rings) ka yogdan” by Dr. SK Sah, Scientist ‘E’, BSIP on 20th March, 2024

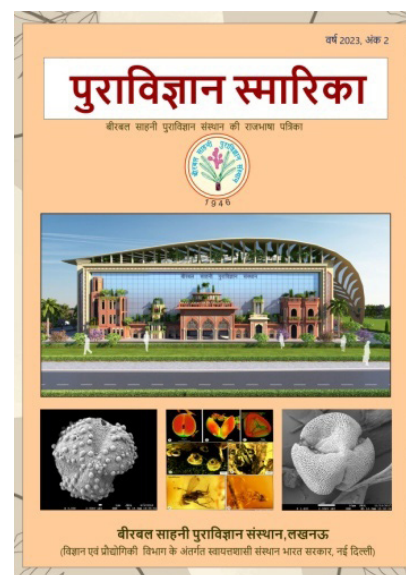
Annual Hindi e-Magazine “Puravigyan Smarika”

As an attempt is to get more and more popular science and general articles in Hindi, this year we published the 2nd issue of Annual Hindi e-Magazine “Puravigyan Smarika”. Authors from various organisations and employees of the institute contributed articles to the magazine. The articles of the magazines are informative and well appreciated by the readers.

Miscellaneous

The bilingual website of the Institute is available for internet viewers. The computers of the Institute with net facility have multi-lingual software. All the essential forms

were made available in bilingual format. A well-maintained section of Hindi books is available at BSIP Library, which is enriched every year by the addition of new Hindi books. The Annual Report 2022-23 of the Institute was published in Hindi also. In the international journal of the Institute, ‘*Journal of Palaeosciences*’ abstracts of all the research papers were published in Hindi. The Convener of the Official Language Implementation Committee, Dr. Poonam Verma, was deputed to attend a conference (Rajbhasha) at Chennai organized by DRDO, New Delhi. Meeting of the Official Language Implementation Committee of the Institute was organized in every quarter of the year for discussing and monitoring the progress of the use of Official Language in various sections. In year 2023, concerted efforts were put forth by BSIP with full dedication towards adherence to the section 3(3) of the Official Language Act 1963.





PERSONNEL

DIRECTOR

Dr (Mrs) Vandana Prasad (Superannuated w.e.f. 31.07.2023)
Dr Kalachand Sain (w.e.f. 01.08.2023 to 03.09.2023)
Professor Mahesh G. Thakkar (w.e.f. 04.09.2023)

SCIENTIST 'G'

1. Dr Anupam Sharma

SCIENTIST 'F'

1. Dr Srinivas Bikkina (w.e.f. 30.06.2023)
2. Dr Ratan Kar
3. Dr (Mrs) Binita Phartiyal
4. Dr Anil Kumar Pokharia

SCIENTIST 'E'

1. Dr Deepa Agnihotri (w.e.f. 01.01.2024)
2. Dr Sadhan Kumar Basumatary
3. Dr Ruby Ghosh, (Expired on 18.4.2023)
4. Dr Pawan Govil
5. Dr Kamlesh Kumar (w.e.f. 01.01.2024)
6. Dr Abhijit Mazumder
7. Dr Krishna Gopal Misra
8. Dr Srikanta Murthy
9. Dr (Mrs) Shilpa Pandey (w.e.f. 01.01.2024)
10. Dr S.Suresh Kumar Pillai
11. Dr Parminder Singh Ranhotra
12. Dr (Mrs) K. Pauline Sabina
13. Dr (Mrs) Anju Saxena
14. Dr Santosh Kumar Shah
15. Dr (Mrs) Anumeha Shukla (w.e.f. 01.01.2024)
16. Dr Hukam Singh
17. Dr (Ms) Vartika Singh
18. Dr Veeru Kant Singh
19. Dr Gaurav Srivastava (w.e.f. 01.01.2024)
20. Dr Biswajeet Thakur
21. Dr (Ms) Swati Tripathi (w.e.f. 01.01.2024)
22. Dr (Mrs) Anjali Trivedi
23. Dr (Mrs) Poonam Verma

SCIENTIST 'D'

1. Dr (Mrs) Abha
2. Dr (Mrs) Neha Agarwal
3. Dr Shailesh Agarwal

4. Dr Sheikh Nawaz Ali
5. Dr Arif Hussain Ansari
6. Dr Vivesh Vir Kapur
7. Dr Manoj M.C.
8. Dr Runcie Paul Mathews
9. Dr P. Morthekai
10. Dr (Mrs) Neelam
11. Dr Santosh Kumar Pandey
12. Dr Mohd. Firoze Quamar
13. Dr Niraj Rai
14. Dr Sunil Kumar Shukla
15. Dr Jyoti Srivastava

SCIENTIST 'C'

1. Dr Mohammad Arif
2. Dr Ansuya Bhandari
3. Dr Trina Bose
4. Dr Gurumurthy G.P
5. Dr Niteshkumar Narendra Khonde
6. Dr Prasanna K.
7. Dr (Mrs) Yogmaya Shukla
8. Dr Arvind Kumar Singh

SCIENTIST 'B'

1. Dr Adrita Choudhuri
2. Sri Sanjay Kumar Singh Gahlaud
3. Dr Anurag Kumar
4. Sri Sabyasachi Mandal
5. Dr Divya Kumari Mishra
6. Dr (Mrs) Shreya Mishra
7. Dr Ranveer Singh Negi
8. Dr Suman Sarkar
9. Dr Mayank Shekhar
10. Dr Prem Raj Uddandam

TECHNICAL OFFICER 'D'

1. Sri Madhukar Arvind
2. Sri Pavan Singh Katiyar
3. Dr Subodh Kumar
4. Sri Rattan Lal Mehra
5. Sri Yogendra Pratap Singh

TECHNICAL OFFICER 'B'

1. Dr Syed Rashid Ali
2. Sri Digamber Singh Bisht

(The names are in alphabetical order according to surnames)



3. Sri Dhirendra Kumar Pal
4. Sri Dhirendra Sharma
5. Dr Sanjai Kumar Singh

TECHNICAL OFFICER 'A'

1. Sri Sumit Bisht
2. Dr Nilay Govind
3. Sri Ishwar Chandra Rahi
4. Mrs Nandita Tiwari

TECHNICAL ASSISTANT 'E'

1. Sri Amrit Pal Singh Chaddha
2. Dr Prasanta Kumar Das
3. Sri Pawan Kumar
4. Sri Madan Singh Rana
5. Ms Kirti Singh
6. Sri Ajay Kumar Srivastava

TECHNICAL ASSISTANT 'D'

1. Sri Sandeep Kumar Kohri
2. Sri Ishwar Chandra Shukla
3. Sri Jitendra Yadav

TECHNICAL ASSISTANT 'B'

1. Sri J. Baskaran
2. Sri Ashok Kumar Sharma
3. Ms Shivalee Srivastava
4. Sri Ram Ujagar
5. Sri Raja Ram Verma

TECHNICAL ASSISTANT 'A'

1. Ms Archana Sonker
2. Sri Shailendra Kumar Yadav

REGISTRAR

Sri Sandeep Kumar Shivhare

ACCOUNTS OFFICER

Sri Ashutosh Shukla

SECTION OFFICER

1. Sri Mishri Lal
2. Sri N.U. Kannan, (superannuated on 31.8.2023)
3. Mrs Swapna Mazumdar
4. Sri Shailendra Singh Panwar (w.e.f. 12.11.2023)

5. Sri K.P. Singh
6. Sri Gopal Singh

ASSISTANTS

1. Sri Rameshwar Prasad
2. Sri Avinash Kumar Srivastava
3. Mrs Manisha Tharu

HINDI TRANSLATOR

Sri Ashok Kumar

UPPER DIVISION CLERK

1. Sri Rahul Gupta
2. Ms Anupam Jain
3. Mrs Sudha Kureel
4. Sri Rajesh Kumar Mishra
5. Sri Manoj Singh

LOWER DIVISION CLERK

1. Sri Akshay Kumar
2. Sri Shailesh Kumar
3. Sri Purneshwar Prakash Mishra
4. Mrs Savita Nair
5. Sri Abhishek Sachan
6. Ms Barsha Shah
7. Sri Abhay Shukla
8. Mrs Vijaya Venkateshwari
9. Sri Pushkar Verma
10. Sri Karan Yadav

DRIVER 'IV'

1. Sri Pushpendra K. Misra

MULTI TASKING STAFF

1. Mrs Bhawana Awasthi
2. Sri R.K. Awasthi
3. Mrs Beena
4. Sri Ram Chander
5. Sri Ram Dheeraj
6. Sri Vishwanath S. Gaikwad
7. Ms Prapti Gupta
8. Sri Palton Ho
9. Mrs Ram Kali
10. Sri Sanjay Kashyap
11. Sri Deepak Kumar
12. Sri Indra Kumar
13. Sri Jitendra Kumar



14. Sri Ramesh Kumar
15. Sri Sunit Kumar
16. Sri Dhan Bahadur Kunwar
17. Sri Manish Mishra
18. Sri Prabhat Mishra
19. Ms Nandani
20. Sri Mani Lal Pal (Supersnnuated on 30.09.2023)
21. Sri Lavkush Pandey
22. Sri Puneet Pandey
23. Sri Mathura Prasad
24. Sri Ashik Gyaniram Saryam
25. Sri Ravi Shankar
26. Sri Aquil Siddiqui
27. Sri Ankit Pratap Singh
28. Sri Ram Singh
29. Mrs Sandhya Singh
30. Sri Indra Kumar Yadav
31. Sri Ram Kewal Yadav (Expired on 26.01.2024)
32. Sri Shivam Yadav

APPOINTMENTS

Scientific Staff

1. Dr. Srinivas Bikkina, Scientist-F (w.e.f. 30.6.2023)
2. Prof. Mahesh G. Thakkar, Director (w.e.f. 04.09.2023)

PROMOTIONS

Scientific Staff

1. Dr Kamlesh Kumar Scientist 'E' (w.e.f. 01.01.2024)
2. Dr (Mrs) Shilpa Pandey Scientist 'E' (w.e.f. 01.01.2024)
3. Dr (Mrs) Anumeha Shukla Scientist 'E' (w.e.f. 01.01.2024)
4. Dr (Mrs) Swati Tripathi Scientist 'E' (w.e.f. 01.01.2024)
5. Dr Gaurav Srivastava Scientist 'E' (w.e.f. 01.01.2024)
6. Dr (Mrs) Deepa Agnihotri Scientist 'E' (w.e.f. 01.01.2024)

Administrative Staff

1. Sri Shailendra Singh Panwar, Section Officer (w.e.f. 12.11.2023)

RESIGNATION

Scientific Staff

1. Dr Mohd. Sajid Ali (resigned on 30.09.2023)

SUPERANNUATION

1. Dr Vandana Prasad, Director (retired on 31.7.2023)
2. Sri Ram Singh, MTS (retired on 31.7.2023)
3. Sri N U Kannan, S.O. (retired on 31.8.2023)

OBITUARY

1. Dr Ruby Ghosh, Scientist 'E' (Expired on 18.04.2023)
2. Sri Ram Kewal (Expired on 26.01.2024)

OTHER SCIENTIFIC STAFF & PROJECT / RESEARCH SCHOLARS

SPONSORED PROJECTS

SENIOR RESEARCH ASSOCIATE

1. Dr Shamim Ahmad, SRA-CSIR

RESEARCH ASSOCIATE

1. Dr Bandana Shukla, ONGC
2. Dr Lomas Kumar, DAM, Govt. of Gujarat

JUNIOR RESEARCH FELLOW

1. Sri Deveshwar Prakash Mishra, DST-SERB
2. Sri Yogesh Kumar, ONGC
3. Ms Vartika Singh, MOES
4. Sri Siddhant Vaish, DST-SERB
5. Sri Abhinav Jain, DST-SERB
6. Ms Ayushi Misra, DST-MoES

PROJECT ASSISTANT

1. Sri Raj Kumar, ONGC
2. Ms Bhawana Ahlawat, DSM, Govt. of Gujarat
3. Ms Stuti Saxena, ONGC
4. Sri Yogesh Pal Singh, ONGC
5. Ms Arya Pandey, DST-SERB

TECHNICAL ASSISTANT

1. Sri Sachin Kumar Dhiman, ONGC
2. Sri Sumit Kumar, ONGC



SELF SUPPORTED Ph.D. (DST-INSPIRE, CSIR, UGC)

SENIOR RESEARCH FELLOW

1. Sri Mukesh Yadav, CSIR-NET
2. Sri Nikhil Patel, UGC-NET
3. Sri Md. Munazir Chauhan, CSIR-NET

DST-INSPIRE FELLOW

1. Ms Deeksha
2. Ms Lopamudra Roy
3. Ms Stuti Saxena
4. Sri Vijay Kumar Rathaur

PH.D. SCHOLARS REGISTERED UNDER AcSIR PROGRAMME (In alphabetical order of First Name)

CSIR-NET

1. Sri Ahmad Shafi
2. Sri Gursewak Singh
3. Sri Harsh Kumar
4. Sri Jereem Thampan
5. Sri Mohd Ikram
6. Sri Nagendra Prasad
7. Ms. Prachita Arora
8. Ms. Sabera Khatoon
9. Sri Shirish Verma

DST-INSPIRE FELLOW

1. Ms. Adhra Renny
2. Sri Anand Rajoria
3. Sri Hidayatullah
4. Sri Katange Kishor Vasant
5. Ms. Maneesha Muraleedharan ET
6. Ms. Mansi Swaroop
7. Sri Mohammad Arif Ansari
8. Ms. Pooja Nitin Saraf
9. Sri Prashant Mohan Trivedi
10. Ms. Rashmi
11. Sri Ravi Shankar Maurya
12. Sri Sangram Sahoo
13. Sri Shivansh Saxena
14. Ms. Sneha Mary Mathew
15. Sri Suraj Kumar

DST-SERB

1. Ms. Korobi Saikia, SRF
2. Sri Ramanand Sagar, JRF
3. Sri Sachin Srivastava
4. Sri Sadanand Pathak, SRF

MoES

1. Sri Piyal Halder

PROJECT FELLOW

1. Sri Alok Kumar Mishra
2. Sri Amal M S
3. Sri Arunaditya Das
4. Ms. Ayushi Mishra
5. Ms. Harshita Bhatia
6. Sri Jinamoni Saikia
7. Sri Pawan Kumar Singh

NCAOR

1. Sri Masud Kawsar

SAC-ISRO

1. Ms. Nidhi Tomar

SELF SPONSORED

1. Ms. Archana Sonker, (Technical Staff)

UGC-NET

1. Ms. Aparna Dwivedi
2. Sri Arvind Tiwari
3. Sri Brijesh Kumar
4. Ms. Divya Verma
5. Sri Faizan Ahmad Khan
6. Sri Kumail Ahmad
7. Ms. Mitra Rajak
8. Ms Sadhana Vishwakarma
9. Sri Nazakat Ali
10. Ms. Priya Dixit
11. Sri Pushendra Pandey
12. Ms. Richa Rajpal
13. Ms. Samiksha Shukla
14. Sri Satendra Kumar Gupta
15. Sri Shubhajit Ghosh
16. Sri Shubham Mishra
17. Ms. Snigdha Konar

INTERNAL COMMITTEES

Research Development & Co-ordination Cell (RDCC)



L to R: Hukam Singh, Anupam Sharma, Mahesh G Thakkar, Pauline Sabina Kavali, Vivesh Vir Kapur

Internal Grievances Committee (SC/ST)



L to R: Srikanta Murthy, Hukam Singh, Sadhan Kumar Basumatary, S. Suresh Kumar Pillai,

Liason Officer For SC/ST



Srikanta Murthy

AcSIR Committee



L to R: K.G. Mishra, Ratan Kar, Mahesh G Thakkar, P Morthekai, Srinivas Bikkina

Quotation Opening & Tender Monitoring Committee



L to R: Archana Sonker, Swapna Mazumder, Vartika Singh, Sadhan K. Basumatary, Anjali Trivedi, Shailesh Agrawal, Sandeep K. Shivhare, Ashutosh Shukla

Maceration Committee



L to R: Deepa Agnihotri, Abhijit Mazumder, Anil K. Pokharia, Poonam Verma, Rajaram Verma, APS Chaddha

Media Coverage & Press Release Committee



L to R: Deepak Kumar, Sanjay KS Gahlaud, Arvind K. Singh, Swati Tripathi, Mayank Shekhar, Shivalee Srivastava, Nilay Govind

Museum & Herbarium Committee



L to R: Nilay Govind, Ram Ujagar, Pawan Kumar, Gaurav Srivastava, Hukam Singh, Shilpa Pandey, Ranveer Singh, Dheeraj, Sanjai Singh



Internal Complaints Committee



L to R: Gaurav Srivastava, Manisha Tharu, Anju Saxena, Binita Phartiyal, Sandeep K Shivhare, Akshay Kumar

Deputation for Scientific / Research Conferences & Workshops Committee



L to R: Runcie Paul Mathews, Hukam Singh, Shilpa Pandey, G.P. Gurumurthy

Information, Documentation & Knowledge Resource Centre Committee



Sitting L to R: Veeru Kant Singh, Binita Phartiyal, S. Nawaz Ali
1st Row L to R: Bhawna Awasthi, Nandita Tewari, Dharendra Sharma, Niteshkumar Khonde
2nd Row L to R: Indra Kumar, Sumit Bisht

Office Automation Committee



Sitting L to R: Pavan S. Katiyar, Biswajeet Thakur, Santosh K. Shah, Yogendra P. Singh
Standing L to R: Ajay K. Srivastava, Trina Bose, Nilay Govind

Auditorium & Audio-Visual Committee



L to R: Madan S. Rana, Shailendra S. Panwar, Santosh K. Shah, Pavan S Katiyar, Nilay Govind

Outreach Activities Committee



L to R: Y.P. Singh, Amrit Pal Singh Chaddha, Shilpa Pandey, Kamlesh Kumar, Sanjai K. Singh

Swachhata Action Plan Committee



L to R: Shailendra S Panwar, Kamlesh Kumar, Yogmaya Shukla, Sadhan K.Basumatary, Suman Sarkar, Sunil K. Shukla, Ashok Kumar, Sudha Kureel

Staff Welfare Committee



1st Row L to R: Anjali Trivedi, Deepa Agnihotri, Vartika Singh, Poonam Verma, Manisha Tharu; **2nd Row L to R:** Rajesh K Awasthi, Gaurav Srivastava, Shailesh Kumar

International Yoga Committee



L to R: Ansuya Bhandari, Jyoti Srivastava, Kamlesh Kumar, Ashok Kumar

Whole Section Cutting Committee



L to R: Arvind K. Singh, Vivesh Vir Kapur, Anumeha Shukla, Santosh Kumar Pandey, Palton Ho

National Accreditation Board for Testing & Calibration Laboratories (NABL) Committee



L to R: Prasanta K. Das, Shailendra S. Panwar, Kamlesh Kumar, P.S. Ranhotra, Manoj Singh, Shailesh Agrawal, Subodh Kumar, P. Morthekai

Stores & Stock Verification Committee



L to R: A.H. Ansari, Dharendra Sharma, P.S. Ranhotra, S. Suresh K. Pillai, Vartika Singh, Poonam Verma, Swapna Majumder

Cultural / Compering Committee



L to R: Shivalee Srivastava, Anumeha Shukla, Sanjay K. Singh, Shilpa Pandey, Neelam Das

Periodical Reports/MoU to DST & Parliamentary Queries, Etc. Related Committee



Sitting L to R: Neha Aggarwal, Anupam Sharma, Vivesh Vir Kapur, **Standing L to R:** Madhukar Arvind, Arvind K. Singh

Centre for Promotion of Geoheritage & Geotourism (CPGG)



L to R: Akhilesh Kumar Yadava, Vivesh V. Kapur, Mahesh G. Thakkar, Sanjay K. Singh, Shilpa Pandey

Building Repair & Maintenance Monitoring Committee



1st Row L to R: Prasanta Kumar Das, Abhay Shukla, Veeru Kant Singh, Prem Raj Uddandam, Sunil Kumar Shukla, Abha Singh, **2nd Row L to R:** Shailendra S. Panwar, Pawan Govil, Gurumurthy G.P.



Garden / Decoration / Photography Committee & Garden Staff



1st Row L to R: Inder Kumar Yadav, Jitendra Yadav, Abhijit Mazumder, Adrita Choudhuri, Ansuya Bhandari, Barsha Shah, D.S. Bisht,
2nd Row L to R: Ram Chander, Pawan Kumar, Mathura Prasad

SECTIONS / UNITS

Director's Office



1st Row L to R: M JagathJanani, Mahesh G Thakkar, Madhukar Arvind
2nd Row L to R: P.K. Misra, Dhan B Kunwar, Puneet Pandey

Registrar's Office



1st Row L to R: Karan Yadav, Sandeep Kumar Shivhare, Rahul Gupta
2nd Row L to R: Jitendra Kumar, Prabhat Mishra, Prapti Gupta, Pushkar Verma, Vishwanath S. Gaikwad

Accounts Office



Sitting L to R: Lavkush Pandey, Ashutosh Shukla, Rajesh K. Mishra
Standing L to R: Aquil Siddiqui, Purneshwar P. Mishra, Rajesh K. Awasthi, Barsha Shah

Establishment Section



L to R: Akshay Kumar, Mishri Lal, Rameshwer Prasad

Sponsored Projects Section



L to R: Sandhya Singh, Avinash K. Srivastava, Inder Kumar, Abhay Shukla

Works & Building Section



L to R: Shailendra S. Panwar, Shailesh Kumar, Sanjay Kashyap, Ashok Sharma, Madan Singh Rana

Stores & Purchase Section



Sitting L to R: Swapna Majumder, S. Suresh K. Pillai, Dheerendra Singh
Standing L to R: Anupam Jain, Manish Mishra, Manoj Kumar, Shailendra Yadav

Scientific Activity Section



L to R: Sh. Wasiullah Khan, Manisha Tharu, Savita Nair, Gopal Singh

Security Staff



Sanitation Staff





EVENTS

Death Anniversary of Prof. Birbal Sahni: April 10, 2023

Floral tributes were offered to Late Prof. Birbal Sahni on his Samadhi at the Institute premises on 10th April, 2023 by scientific, technical and administrative staff of the Institute.



Swachhta Pledge and Swachhta Action Plan: May 1-15, 2023

A cleanliness campaign was conducted in the BSIP premises under Swachhta Action Plan during 1-15 May 2023 where monitoring and cleaning of laboratories/ lavatory and plantation in the Institute premises was done.



May 1, 2023 - BSIP staff took a Swachhta Pledge under Swachh Bharat Abhiyan. On May 10, 2023 - BSIP teamed up for a plantation drive in the campus garden as part of Jan Bhagidari & Swachh Bharat Abhiyan to inspire others towards environmental conservation & fight against climate change. Water quality testing in different labs & units at BSIP under the Swachhta Action Plan was done ensuring clean water for all.

International Conference on “Decoding the population histories of South Asia using Archaeogenetics”: June 7-9, 2023

BSIP and University of Kashmir, Srinagar jointly organised a 3-days International Conference on “Decoding the population histories of South Asia using Archaeogenetics” held at the University of Kashmir, Srinagar from June 7-9, 2023. Scientists from BSIP attended and delivered talks in the Conference.



हिंदी कार्यशाला के अंतर्गत व्याख्यान: जून 19, 2023

हिंदी कार्यशाला के अंतर्गत डॉ. पूनम वर्मा, वैज्ञानिक बी.सा.पु.सं. ने ‘सीनोजोइक पुरापरगाणु विज्ञान: परिचय एवं अनुप्रयोग’ के विषय पर व्याख्यान दिया। संस्थान के वैज्ञानिक सदस्य और परियोजना स्टाफ सदस्य, अनुसंधान सहयोगी और विद्वानों ने वार्ता में भाग लिया।





9th International Day of Yoga Celebration: June 21, 2023

International Yoga Day 2023 was celebrated in BSIP by conducting a gentle yoga flow session under the guidance of Dr. Jyoti Srivastava, Scientist BSIP followed by a Pranayama sequence guided by Dr. Prem Raj Uddandam, Scientist BSIP. Institute staff including scientists, research

associates and research scholars participated in the yoga practice session. The program was kept as a zero-waste event to motivate reduction of carbon footprint to the environment following one earth, one family, one future theme of International Day of Yoga 2023.



माननीय संसदीय राजभाषा समिति का भौतिक निरीक्षण: जून 21-24, 2023

संसदीय राजभाषा समिति ने 22 जून 2023 को लखनऊ में बीरबल साहनी पुराविज्ञान संस्थान के साथ निरीक्षण बैठक की। इस दौरान समिति ने मंत्रालय एवं विभाग के वरिष्ठ अधिकारियों की उपस्थिति में हो रहे राजभाषा हिंदी के कार्यों का अवलोकन किया।



Governing Body Meeting: June 29, 2023





INQUA (International Union for Quaternary Research) Congress 2023: July 13–20, 2023

The 21st INQUA Congress was organised at Rome, Italy, during July 13–20, 2023. A group of scientists from BSIP including Dr Vandana Prasad, Director, BSIP, senior scientists and research scholars attended the congress and presented their research work. Scientists and students from other institutions and universities of India also participated in the Conference. BSIP along with the Department of Science and Technology (DST), Ministry of Earth Sciences (MoES), Indian National Science Academy (INSA), National Centre for Polar and Ocean Research

(NCPOR) and Association of Quaternary Researchers (AOQR) participated and won the bid to host the 22nd INQUA Congress in BSIP, Lucknow. The Ambassador of India to Italy, Dr Neena Malhotra, delivered the acceptance speech at the event. Dr Binita Phartiyal, Scientist-F, BSIP has been appointed as Organising Secretary for INQUA 2027. For the first time, India will host the prestigious International Union for Quaternary Research (INQUA) Congress in 2027.



Independence Day Celebrations: August 15, 2023

BSIP celebrated 77th Independence Day by hoisting the national flag by Dr Anupam Sharma, the senior most scientist of the Institute and singing the National Anthem on 15th August 2023 within its campus followed by various performances by the Institute staff members. All the BSIP staff including research scholars and associates participated in flag hoisting ceremony.



Joining of Prof. Mahesh G Thakkar as Director of Birbal Sahni Institute of Palaeosciences, Lucknow: September 4, 2023

Prof. Mahesh G Thakkar, Head of the Department of Earth & Environmental Science & Dean of the Faculty of Science in KSKV Kachchh University, Gujarat joined as the new Director of Birbal Sahni Institute of Palaeosciences, Lucknow on 4th September 2023.





Foundation Day Celebration: September 10, 2023

BSIP celebrated its 77th Foundation Day Function on September 10, 2023, at its campus by offering floral tribute to Late Prof. Birbal Sahni by Director, Prof. Mahesh G Thakkar along with other scientific, technical, and administrative staff members of the Institute. On this auspicious occasion, Prof. Nitin R. Karmalkar, Chairman,

Governing Body, BSIP delivered a lecture on “Flood Basalts - A Journey through the Deccan”. The event was well attended by all the scientists, technical and administrative staff and research scholars of the Institute. The second issue of "पुराविज्ञान स्मारिका पत्रिका" was also released during the event, showcasing the latest research in Palaeosciences.



हिंदी पखवाड़ा समारोह: September 14-24, 2023

हिंदी पखवाड़ा के उद्घाटन समारोह में प्रो. ध्रुव सेन सिंह जी ने एक महत्वपूर्ण विचारशील विषय 'जलवायु परिवर्तन: प्राकृतिक या मानवजनित?' पर व्याख्यान दिया। हिंदी पखवाड़ा 2023 के अंतर्गत BSIP में टंकण, टिप्पण, अनुवाद प्रतियोगिता में BSIP के कर्मचारियों व शोधार्थियों ने प्रतिभाग किया और अपनी राजभाषा के प्रति अपना समर्पण दिखाया। "कृत्रिम बुद्धिमत्ता (आर्टिफिशियल इंटेलिजेंस) तकनीक: मानव संसाधन में सहायक या बाधक" विषय पर वाद-विवाद प्रतियोगिता में BSIP कर्मचारियों व शोधार्थियों ने उत्साह से प्रतिभाग किया जिससे दर्शक दीर्घा में भी रचनात्मक विचार-उत्तेजना का संचार हुआ।





स्वच्छता पखवाड़ा: September 15 - October 2, 2023

स्वच्छता पखवाड़ा, 2023 के अंतर्गत वृक्षारोपण कार्यक्रम का आयोजन दिनांक 2 अक्टूबर को BSIP के प्रांगण में सफलता पूर्वक आयोजित किया गया।

"Ek Tareekh, Ek Ghanta, Ek Saath", all members of BSIP dedicated 1:00 hour of shramdaan to make our nation cleaner & greener on October 1, 2023.



Earth Science Week: October 8-14, 2023

Center for Promotion of Geoheritage & Geotourism, (CPGG-BSIP) organised & celebrated “Earth Science Week- 2023” themed “Geoscience innovating for Earth & People” to engage young researchers & public to sensitise towards the role of Earth Sciences. Chief Guest Dr. Navin Juyal delivered an engaging talk on “Significance of Geoscience & its Societal Implications in the Himalayan region”. BSIP scientists also delivered talks during the occasion to enlighten the students about Earth Sciences and Fossils. 2nd day of Earth Science Week was marked

with engaging laboratory & museum visits, offering students a unique opportunity to explore the fascinating world of fossils. On the 3rd day, a Geoscience Competition on “Earth and Society” was organised in which students participated with enthusiasm. The function was concluded by a speech from the Chief Guest of the day Dr. Suchita Chaturvedi, Member, Child Commission, UP followed by the presidential remarks from Prof. MG Thakkar, Director BSIP.



Vigilance Awareness Week: October 30- November 5, 2023

All the staff members of BSIP took the “Integrity pledge” for Vigilance Awareness Week 2023, embracing the theme “Say no to corruption; commit to the nation”. In this connection poster and essay competitions were also

organised in the Institute. The topic of the essay competition was “Role of Information Technology in making India corruption free”; and the topic of the poster competition was “Say no to corruption; commit to the nation”.





Special Cleanliness Campaign 3.0

BSIP conducted a thorough cleanliness drive throughout the month of November, where the staff members cleaned and organised the various laboratories and sections of the Institute premises.



Founder's Day Celebration: November 14, 2023

Institute celebrated its Founder's Day on November 14, 2023 with a floral tribute to the visionary founder Late Prof. Birbal Sahni. His enduring dedication to Palaeosciences continues to serve as a source of inspiration. On this occasion, 53rd Birbal Sahni Memorial Lecture was delivered by Prof Ashok Sahni on "India on Collision course: A

journey that changed the Planet" & 65th Albert Seward Memorial Lecture was delivered by Prof Dhruv Sen Singh, Professor in Geology, University of Lucknow, Lucknow. An amber analysis & Palaeoentomology laboratory was also inaugurated at BSIP by Prof Ashok Sahni.





राजभाषा कार्यान्वयन समिति का निरीक्षण, गृह मंत्रालय, भारत सरकार: November 23, 2023

The Committee on official languages (Hindi), Official Language Department, Home Ministry, GOI visited BSIP on 23 Nov. 2023 for inspection on the targets laid down for promotion of use of Hindi language in day to day official workings of BSIP. The committee successfully completed the inspection and appreciated the efforts of BSIP staff.



Indian Association of Sedimentologists (IAS) Conference at Annamalai University: December 6 – 8, 2023

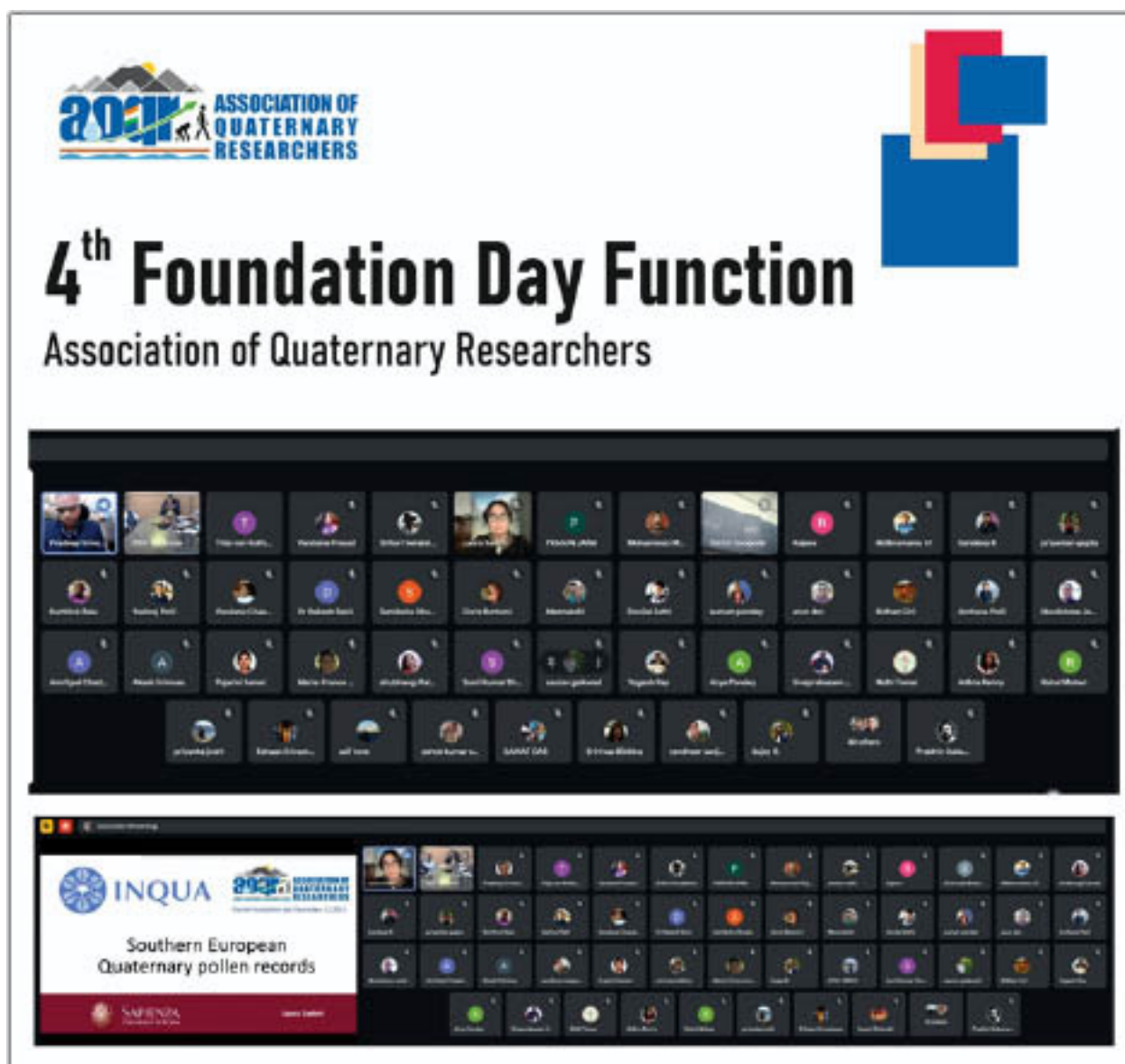
A group of BSIP scientists and research scholars working in various domains of sedimentology and sedimentary geology participated in 39th IAS Convention-cum-International Conference on “Voyage of Sedimentology from the Mountains to the Oceans: An Innovative Trajectory” at Department of Earth Sciences, Annamalai

University, Chidambaram, Tamil Nadu. BSIP also participated and won the bid to host the 40th Convention-cum-Conference of Indian Association of Sedimentologists in BSIP, Lucknow around December 2024. For the first time, BSIP will host the prestigious 40th Convention cum Conference of Indian Association of Sedimentologists.

Fourth Foundation Day Function of AOQR: December 12, 2023

Association of Quaternary Researchers (AOQR) celebrated its Fourth Foundation Day on December 12th, 2023 (Online). Prof. Laura Sadori, President, INQUA graced the occasion as a Chief Guest, who also delivered a talk on “Southern European Quaternary pollen records”

The event was attended by professors, scientists and research scholars from various institutes across India and abroad such as Wadia Institute, BSIP, Lucknow University, Kumaon University, French Institute of Pondicherry, Delhi University, etc.





Exposure Visit Program for CBSE School Principals: December 14 -15, 2023

BSIP in collaboration with CBSE organised two day exposure visit program for Principals of CBSE affiliated schools. A total of 55 principals belonging to schools of Lucknow, Agra, Gorakhpur, Mirzapur, Meerut, Barabanki, Unchahar, Firozabad, Hardoi, etc. participated in the program. The program was organised with a motto to

understand the current state of technological developments in the field of science and how it will benefit school curriculum. During the program, Principals of various schools also visited the BSIP Museum and various scientific laboratories.



Inauguration of AcSIR Science Club: December 20, 2023

The Birbal Sahni Institute of Palaeosciences, Lucknow has inaugurated the 'Science Club' for PhD students pursuing PhD in BSIP under the banner of Academy of Scientific and Innovative Research (AcSIR) on 20th December 2023. The essence and importance of this club is that it will be managed and run entirely by PhD students with the motto to encourage scientific communication and enhance social adaptability so that students feel free to discuss science and improve their scientific skills.





तिमाही हिंदी कार्यशाला: December 27, 2023

Shri Chand Mohan Tripathi, Hindi Officer (Rtd), Indian Institute of Toxicology Research (IITR) delivered a lecture on Official Language Management. The lecture was attended by all the scientists, technical, research staff, students and administrative staffs of the institute.



10th B.S. Venkatachala Memorial Lecture: January 2, 2024

Prof. Mahesh G. Thakkar, Director BSIP, delivered the 10th B.S. Venkatachala Memorial Lecture on the topic “Advances in Earthquakes and active fault research in Kachchh. Do we use this valuable data?” on 2nd January 2024 at BSIP campus. The Talk was attended by all the scientists, technical, administration, research scholars and project staff of the Institute.



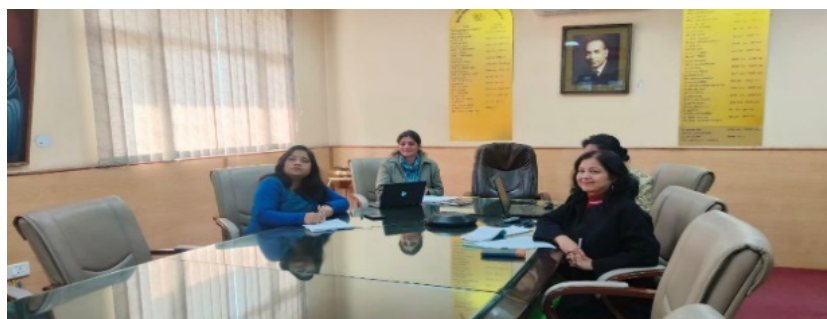
Republic Day Celebration: January 26, 2024





First South Asian Biodiversity Council (SABDC) Meeting: February 2, 2024

First South Asian Biodiversity Council meeting was held at BSIP in an online mode with stakeholders from academia and industry. Detailed discussion on conservation of ecology, vegetation and environment took place with a motto of sustainable development.



Present Council ...

Hosting Institution: Birbal Sahni Institute of Palaeosciences (BSIP)		
M.G. Thakkar	Director	K. Ilango
Yandana Prasad	Ex-Director	Environment, Forest and Climate Change Dept., UP
Anupam Sharma		Naveen Gandhi
Binika Phartiyel		Indian Institute of Tropical Meteorology
Anjali Trivedi		Navya Reghu
Trina Bose		French Institute of Pondicherry
Sandhya Mishra		Nayanjot Lahiri
Akash Srinivas	IAR, Ashoka University	N P Singh
A K Kanungo	HSS, IIT Gandhinagar	Parth Chauhan
Anindya Sarkar	Geology and Geophysics, IIT Kharagpur	HSS, IISER Mohali
Arti Garg	Botanical Survey of India	P Sukumaran
Bharat Pradhan	Dept of Forest and Environment, Sikkim	P A Srivastava
Bliswajit Roy	National Centre for Polar and Ocean Research	Rajeev Patnaik
D P Pathak	CDG, Tribhuvan University, Nepal	Ruman Banerjee
Debahuti Mukherjee	Geological Survey of India	Pondicherry University
Bhavya P S	EES, IISER Thiruvananthapuram	Sharma Centre for Heritage Education
Haseer Kshirsagar	(2024-02-02 05:32 GMT)	EES, Nalanda University
K. Anupama	French Institute of Pondicherry	Shyam S Phartyal
		Srirang R. Yadav
		Shivaji University, Kolhapur
		Subir Bera
		Botany, University of Calcutta
		T R Premathilake
		Archaeology, U of Kelaniya, Sri Lanka
		National Botanical Research Institute
		Botany, JGASLRPC College Amnori, Gadchiroli
		V K Kanalkar



World Wetlands Day Celebration: February 2, 2024

BSIP celebrated this year's World Wetlands Day with a theme "Wetlands and Human Being" on 2nd Feb 2024 with organising scientific awareness program and fieldwork for school and college students in wetlands nearby Lucknow. The event was led by Institute scientists including Dr Shilpa Pandey, Dr Vartika Singh, Dr Firoz Quamar along with technical support staff.



National Science Day Celebrations: February 28, 2024

BSIP celebrated National Science Day on 28th Feb 2024 to commemorate the discovery of the Raman Effect by Indian Scientist CV Raman and also to raise awareness about importance of science with a motto to motivate youngsters to take up science as career option. On this occasion, BSIP conducted a series of lectures program

for students of various colleges/schools around Lucknow. Senior Scientists Dr. Ratan Kar and Dr S. Suresh K. Pillai delivered lectures on Antarctic studies and fossil studies respectively to create awareness about scientific studies and importance in solving societal issues. The program was presided by Prof. Mahesh G. Thakkar, Director BSIP.



Research Advisory Council Meeting: September 8-9, 2023 and March 4-5, 2024

The 59th & 60th Research Advisory Council Meeting was held during September 8–9, 2023 and March 4-5, 2024 respectively in the Committee Room of the Institute. The Chairman and the members of the RAC along with the Director assessed the six monthly progress of the ongoing BSIP In-house projects and provided constructive inputs to develop a roadmap to formulate future research projects

as per the mandate of the Institute. The Director thanked the RAC Chairman and all the members for their constant support to the Institute during the committee's tenure that helped development of BSIP in the field of Palaeosciences and also felicitated the committee members with mementos for their contributions to the Institute's continuous growth.





International Women's Day Celebration: March 08, 2024

BSIP celebrated International Women's Day on 8th March 2024 at its campus with the theme "Inspire Inclusion". The main objective to celebrate this event is to recognise women's social, economic, cultural, and political achievements and also to achieve gender equality and women's well-being in all aspects of life crucial to create prosperous economies and a healthy planet. The Chief Guest of the occasion was Mrs. Prachi Gangwar, DIG forest, MoEFCC, Lucknow and Mrs. Ankita Singh Chauhan, State Tax Officer, GST division Lucknow graced the occasion as Guest of honour.



Quarterly Hindi Workshop Lecture: March 22, 2024

Dr. Santosh K Shah, Scientist-E BSIP delivered a lecture on the topic “जलवायु परिवर्तन अनुसंधान में वृक्ष-वलय (ट्री-रिंग) का योगदान” on 22 March 2024 during quarterly Hindi Workshop lecture series at the BSIP. The lecture was attended by BSIP scientists, technical staff, research scholars and project staff members.



Friday Lecture series

BSIP conducted a series of lectures during the year 2023-2024 with an aim to provide a platform to early career researchers/research scholars within the institute to showcase their ongoing research work in the field of Earth Sciences and allied subjects and have interactions with subject experts.

Sl. No.	Speaker	Title of the Talk	Date
1.	Dr. Stuti Saxena, BSIP	Neogene biostratigraphy & palaeoceanography of Andaman & Nicobar Basin	April 28, 2023
2.	Dr. Shreya Mishra, Scientist - B, BSIP	Deccan Volcanism: Extinction paradigm & Climate Change across K-Pg boundary	May 15, 2023
3.	Dr. Suman Sarkar, Scientist - B, BSIP	Benthic Foraminifera: their diversity & applications in Palaeogene Biostratigraphy	July 10, 2023
4.	Ms. Vedika Gupta, Ph.D. Scholar	UNESCO Global Geoparks & their potential in promoting geotourism	July 28, 2023
5.	Dr Srinivas Bikkina, Scientist - F, BSIP	Source apportionment of atmospheric dust & particulate OM over the Indian Ocean	August 18, 2023

Student Interaction Forum (SIF) Lecture

The SIF is a forum for discussion on various aspects of science, completely managed by PhD students with faculty coordinator. The following lectures were delivered under this umbrella at BSIP.

Sl. No.	Speaker	Title of the Talk	Date
1.	Dr. Anju Saxena, Scientist - F, BSIP	Origin of Species	November 23, 2023.
2.	Prof. Ravi Bhushan, Scientist, PRL	Radiocarbon Dating & its Applications	January 18, 2024
3.	Mr. Faizan Ahmad Khan, Research Scholar, BSIP	Importance of Reference Materials in Geochemical Studies	February 8, 2024
4.	Dr. Sabyasachi Mandal Scientist-B, BSIP	Unravelling earthquakes in the sedimentary basin	14 March, 2024



OUTREACH ACTIVITIES

Fossil display at Jharkhand: April 11-12, 2023

BSIP Team (Drs. Srikanta Murthy, Anju Saxena, S Suresh K Pillai & Mr Suraj Kumar Sahu) displayed fossils at Rastriya Madhya Vidyalaya Maal Godda District, Jharkhand & at auditorium of District Collectorate Sahibganj, Jharkhand as part of the Jan Bhagidari Program.



Plantation Program in Goalpara District, Assam: April 16, 2023

DST-BSIP organised a colossal awareness & plantation program of rare & common orchids among the local people of Bodo Tribes in Goalpara District, Assam under the aegis of Jan Bhagidari outreach event lead by Dr Sadhan K Basumatary, Scientist, BSIP.



Indo-German Science & Technology (IGSTC) Outreach event, Lucknow: April 18, 2023

BSIP scientists participated in the Indo-German Science & Technology (IGSTC) Outreach event at Lucknow on 18th April, 2023.



Salkhan Fossil Park visit: April 22-28, 2023

BSIP scientists (Dr Veeru Kant Singh, Dr Santosh K Pandey and Dr Arvind K Singh) visited Salkhan Fossil Park for educating and spreading awareness among local people on spectacular preservation of 1.6 billion years old circular stromatolites of Fawn Limestone, Kheinjua Formation, Sonbhadra, Uttar Pradesh. The park exhibits earliest signatures of life on the Earth and managed by UP Forest Department and UP Tourism.



Field visit to OIL Headquarters, Duliajan, Assam: May 22-26, 2023

BSIP Team successfully accomplished their visit to the Field Headquarters of Oil India Ltd. in Duliajan, Assam from 22-26 May 2023 for showcasing the expertise of BSIP in the field of micropalaeontology. It was followed by fruitful brainstorming meetings and discussions on exciting upcoming projects under the MoU signed between BSIP and OIL, Assam.





Marking World Environment Day with Jan-bhagidari at the 'Yuva Utsav 2023-24' in Tribal District Kinnaur, Himachal Pradesh: June 5, 2023

Dr. Ranveer Singh Negi participated in the District level Youth Festival organised by the Nehru Yuva Kendra Sangathan (NYKS), Kinnaur (Ministry of Youth Affairs and Sports, Govt. of India) on the occasion of 5th June-The World Environment Day, to promote the Janbhagidari; a Govt. of India initiative, under the Birbal Sahni Institute of Palaeosciences' (BSIP) umbrella. Ms Torul S Raveesh, Deputy Commissioner of Kinnaur, presided over the festival, which was attended by around 250 youths aged 15 to 28, from several regions of the district. Cultural events, declamation contest and a painting competition,

complemented the celebration. The fossils and other displays attracted the locals to the BSIP exhibition, where interactive workshops were carried out to highlight the importance of Palaeosciences, in understanding ancient life and in seeking the answers to present climate difficulties, etc. Honourable DC Kinnaur, the District Youth Coordinator of NYKS, the Principals of the Senior Secondary School and Industrial Training Institute, along with other district administrators and locals, visited the BSIP stall and were captivated by the fossils and displays.



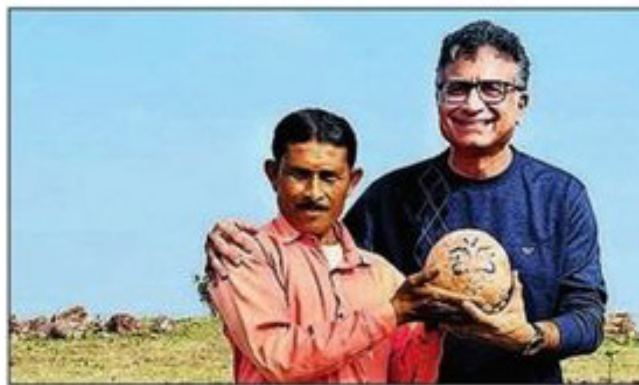
STEMM Podcast interview of BSIP scientists for science popularization: September 5, 2023

Dr. Anupam Sharma and Dr. Arvind K Singh coordinated organised STEMM Podcast interview of BSIP scientists that was conducted on 5th September 2023 by Department of Science and Technology, New Delhi, aiming to popularise and communicate Science and Technology in society. A total of 20 scientists recorded their podcasts based on their scientific achievements.



Visit to the National Dino Fossil Park in Bagh Town, Madhya Pradesh: December 7–8, 2023

Prof. Mahesh G. Thakkar and Dr. Shilpa Pandey visited National Dino Fossil Park in Bagh Town, Dhar District, Madhya Pradesh from 7th – 8th December 2023 under the banner of Center for Promotion of Geoheritage and Geoconservation (CPGG-BSIP) to sensitise local villagers about fossilized dinosaur eggs and science behind Kakad Bherav;s untold story.



Participation of BSIP at Bhartiya Vigyan Sammelan 2023: December 21-24, 2023

BSIP participated and showcased good scientific practices and unique fossil collection in Bhartiya Vigyan Sammelan 2023 held from 21st to 24th December 2023 in Ahmedabad, Gujarat. The stall was visited by honourable Chief Minister of Gujarat, Shri Bhupendra Patel and other dignitaries.





Showcasing BSIP's participation at India International Science Festival (IISF): December 29, 2023

BSIP organised a one-day science outreach program under the banner of India International Science Festival on the 29th December 2023 with a theme on “Science and Technology public outreach in Amrit Kaal”. The Chief Guest of the Function was Dr. Sanjay Singh, DG UPCAR. The Guest of Honour for the Function were Prof. N.B.

Singh, Vice Chancellor, KMCLU Lucknow, Dr. Arvind Kumar, President, Vigyan Bharti and Shreyanch Mandloi, Organising Secretary, Vigyan Bharti, UP. The outreach program was attended by students of various schools within Lucknow District along with BSIP scientific staff and administrative staff.



BSIP participated and showcased good scientific practices and unique fossil collection in India International Science Festival held from 17th to 20th January 2024 in Faridabad, Haryana. The stall was visited by honourable Minister of

Science and Technology, Dr Jitendra Singh, DST Secretary, Prof. Abhay Karandikar, Dr S. Somnath ISRO, Chairman and other member dignitaries along with students from schools and colleges.



BSIP Museum and laboratory visits

Throughout the year April 2023-March 2024, BSIP opened its doors for students of various schools and colleges to visit the museum and laboratories. The Scientists and Museum Staff of BSIP briefed them regarding the significance of fossils and the state-of-the-art laboratories of the Institute, introducing and inculcating in the young minds a passion

for the field of palaeosciences. Maharishi University of Information Technology, Lucknow (40 students), Acharya Narendra Deo Kisan P.G. College Bahnan, Gonda U.P. (40 students) & Techno Institute of Higher Studies (60 students) visited BSIP Museum, SEM lab, Central Geochemical Facility during May 2023.



Students from K.N. Government PG College Gyanpur Bhadohi U.P. visited BSIP laboratories & Museum under

the scientific outreach programme during July 19, 2023.





40 students Greenland Public School, Lucknow UP &
42 students Chinmaya Vidyalaya NTPC, Raebareli, UP

visited BSIP Museum and Scientific laboratories during
February 2024



Department of Botany, Arya Vidyapeeth College Guwahati
Assam (22 students), Deen Dayal Upadhyay Sitapur UP
Government PG College (55 students), Rajikya Balika
Uttar Madhyamik Vidyalaya, Gonda, UP (85 students),

Bhartiya Mahila Gramodyog Sansthan, Prayagraj, UP
(106 students) & Mahamaya Government Degree College,
Mahona, Lucknow (25 students) visited BSIP Museum
and Scientific Laboratories during March 2024.



Exposure Visit Programme for CBSE Principals (December 14-15, 2023)

In view of the National Education Policy 2020 that emphasises and envisions vocational training for school children from class 6 onwards, CBSE has taken the initiative for the exposure visit of school leaders (Principals) to higher education institutions. These visits aim to update the school leaders on the trending growth in various fundamental disciplines. These leaders will inspire teachers and students and help them understand the educational world beyond the school premises. It will also aid them in understanding the applied approach they need to integrate skill (vocational) education into mainstream education and also utilise the infrastructure of higher institutions like BSIP for practical applicability in a time-shift manner (or during vacations) for the students in the coming time.

Thus, under the guidance of CBSE, New Delhi, the

leadership of Dr. Mahesh G. Thakkar, Director, BSIP, and the supervision of Dr. K.G. Misra, Scientist-E BSIP, and his committee, including the Scientists (Dr. Poonam Verma, Dr. Shilpa Pandey, Dr. Anumeha Shukla, Dr. Kamlesh Kumar, Dr. Sandhya Misra), Technical Staff (Dr. Sanjai Singh, Dr. Nilay Govind, Dr. Amrit Pal Singh Chaddha), and Research Scholars (Dr. Yogesh Pal and Mr. Ravi Shankar Maurya) a two days visit program was organised for the CBSE affiliated school Principals from Uttar Pradesh during 14-15 December 2023. This visit included lectures / demonstrations by eminent scientists and visits to laboratories, administrative sections, library, and museum. During these Lab visits, Principals had hands-on experience with several of the proxies used in research at BSIP. Introduction to laboratory equipment and other sophisticated instruments was done so that these leaders could plan out the visits of their students respectively.





Participation in workshops/invited talks/lectures

A one-day workshop was organised in the University of Ladakh Leh during March 28-April 10, 2023 as a part of collaborative project (BSIP, University of West of England, Bristol, Ladakh Arts and Media Organisation) on 'Ecologies of Water-care in the Himalayas' with a focus on Changthang. Padmashree Chewang Norphel graced the event as the Guest of Honour.



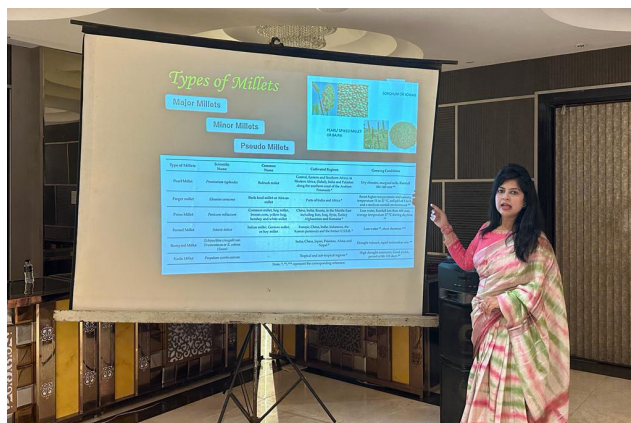
Dr. Shilpa Pandey Scientist, BSIP was invited to deliver a talk on “World Earth Day 2023” by AIR Radio Lucknow “Shaam-E-Awadh” on 22nd April, 2023.



Dr. Shilpa Pandey Scientist, BSIP delivered a talk on “Mangroves & Peatlands in India” at C-PEAT Workshop, Indonesia during May 8-12, 2023 emphasising their crucial role in preventing & mitigating climate change.



Dr. Shilpa Pandey, Scientist BSIP delivered a talk on “Millets as key solution to climate change & food security challenges in Uttar Pradesh” in the National Workshop & Expo on Millets-based products at Jabalpur to commemorate “International Year of Millets” on July 20, 2023.



Talks delivered at the International Union for Quaternary Research (INQUA) Congress Rome 2023: July 13-20, 2023



Dr Swati Tripathi, Scientist BSIP presented a talk on ‘Multiproxy analysis of endangered Yak dung from Indian Himalayas’.

Ms. Korobi Saikia, Research Scholar BSIP presented an informative talk on ‘Analysis of phytoliths & Stable Carbon Isotopes of modern plants & surface soil from Bengal region’.

Ms. Aparna Dwivedi, Research Scholar BSIP presented an informative talk on ‘Reconstructing the Genetic 3 Ancestries of Neolithic & Megalithic Populations of Burzahom, Kashmir using Ancient DNA analysis’

Dr Md. Firoze Quamar, Scientist BSIP presented an enlightening talk on ‘Vegetation dynamics & hydroclimatic variability since the LGM from the core monsoon zone of India’

Ms Priyanka Singh Research Scholar, BSIP presented an informative talk on ‘Do anomalous fading limit the applicability of luminescence dating of Iron ageurns of Sivagalai, South India’.

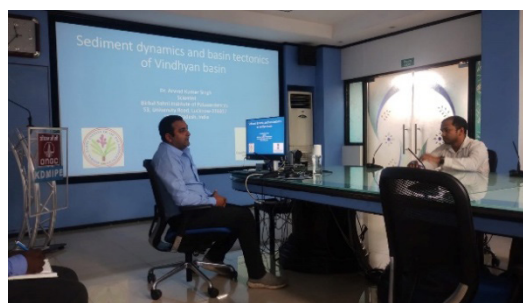
Dr. Nivedita Mehrotra presented INQUA outreach & other activities as INQUA ECR in the 25th ICDP Conference at GFZ Potsdam, Germany during July 13-20, 2023.



Dr. Shilpa Pandey, Scientist BSIP delivered a lecture on “Mangroves as Solution to Climate Crisis” at Babasaheb Bhimrao Ambedkar University (BBAU) & University of Lucknow on August 2, 2023



Dr Arvind Singh, Scientist BSIP delivered a talk on “Sediment dynamics & basin tectonics of Vindhyan Basin” on 29th August 2023 at KDMIPE ONGC Dehradun.



Dr. Ansuya Bhandari, Scientist BSIP, participated in a National Workshop cum Conference on “Biodiversity & Conservation in the Himalayan Region (NWBC)” organised by University of Ladakh between September 25- 27, 2023.



Dr. Swati Tripathi, Scientist ‘E’ BSIP delivered an invited talk on “Climate alterations in Barak Valley, Assam during the last one millennium” at the Department of Applied Geology, Dibrugarh University, Assam. She delivered her talk on the occasion of ‘Dr. S N Vishvanath Scholarship Award event’ at the department during February 2024.



Dr Arvind K Singh, Scientist 'C' BSIP was invited as a resource person and delivered an invited talk on “Mud and Mudstones: a repository of information on low energy environment and its processes” in the Indian Association of Sedimentologists (IAS) Workshop on “Decoding Clastic Sedimentary Systems” at Department of Geology, Aligarh Muslim University, Aligarh during February 2024.



Dr. Gaurav Srivastava and Dr Ranveer Singh Negi were honoured guests at Greenland Public School, Lucknow, to encourage the students, evaluate & felicitate the winners during an Intra-school Science Exhibition held to commemorate the National Science Day 2024.



Dr. Biswajeet Thakur and Dr. Sanjay S. Gahlaud, Scientist, BSIP along with Research Scholar Anand Rajouriya interacted with the Post Graduate students of the Madras University, Chennai. The interaction focussed on Prof. Birbal Sahni's contribution to science and advances in Palaeosciences during March 2024.

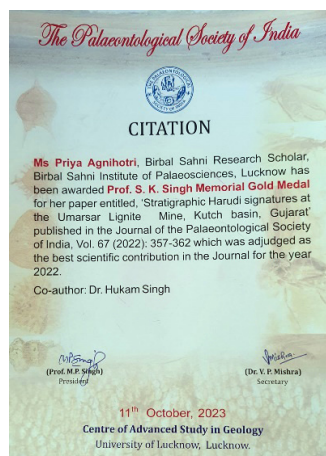




Dr. Veeru Kant Singh, Scientist BSIP, was honoured with the prestigious Sharda Chandra Gold Medal in Paleontology by the Paleontological Society of India.



Ms. Priya Agnihotri, Research Scholar, BSIP, was honoured with the prestigious Prof. S.K. Singh Memorial Gold Medal by the Paleontological Society of India.



Reservation 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 Government of India orders.



ACCOUNTS

MADHUR JAIN & CO.

CHARTERED ACCOUNTANTS

52, Eldeco Greens, Gomti Nagar, Lucknow - 226010;

Tel: 0522 - 4005810; E-mail: mjainco@gmail.com

INDEPENDENT AUDITORS REPORT

To,
The Governing Body,
Birbal Sahni Institute of Palaeosciences,
53, University Road,
Lucknow - 226007

Opinion

We have audited the financial statements of Birbal Sahni Institute of Palaeosciences (the Institute), which comprise the Balance Sheet at March 31st 2024, the Statement of Income and Expenditure and the Receipts & Payments Accounts, for the year then ended, and notes to the financial statements, including a summary of significant accounting policies.

Subject to our comments in Annexure - A to our Independent Auditors Report attached, in our opinion, the accompanying financial statements give a true and fair view of the financial position of the Institute as at March 31, 2024, and of its financial performance for the year then ended in accordance with the Accounting Standards issued by the Institute of Chartered Accountants of India (ICAI).

Basis for Opinion

We conducted our audit in accordance with the Standards on Auditing (SAs) issued by ICAI. Our responsibilities under those standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the entity in accordance with the ethical requirements that are relevant to our audit of the financial statements, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

Responsibilities of Management and Those Charged with Governance for the Financial Statements

Management is responsible for the preparation and fair presentation of the financial statements in accordance with the aforesaid Accounting Standards, and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.



In preparing the financial statements, management is responsible for assessing the entity's ability to continue as a going concern, disclosing, as applicable, matters related to going concern and using the going concern basis of accounting unless management either intends to liquidate the entity or to cease operations, or has no realistic alternative but to do so.

Those charged with governance are responsible for overseeing the entity's financial reporting process.

Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with SAs will always detect a material misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

A further description of the auditor's responsibilities for the audit of the financial statements is located at Institute's website at <https://www.bsip.res.in/>. This description forms part of our auditor's report.

For Madhur Jain & Co.
Chartered Accountants
Firm Reg. No.: 004865C

Sd/-
Madhur Jain, FCA (Partner)
M. No.: 073699
Date: 03-09-2024
Place: Lucknow
UDIN: 24073699BKBNHB7111

ANNEXURE - 'A'

[Annexed to and forming part of the Independent Auditors Report for the year ended 31st March 2024]

COMMENTS / AUDIT OBSERVATIONS ON ACCOUNTS OF 'BIRBAL SAHNI INSTITUTE OF PALAEOSCIENCES, LUCKNOW'

1. As per para 8 of the Schedule 24 - 'Significant Accounting Policies' annexed to the financial statements it is stated that retirement benefits and leave encashment have been accounted for on cash basis. However, we have noticed that provision for pension payable to the tune of Rs. 98.15 lacs has been created on 31.03.2024. Thus, the accounting treatment is contrary to the accounting policy mentioned above.
2. As per Schedule 7 - 'Current Liabilities and Provisions', provisions have been created for various expenses related to salary, pension, retirement benefits, project overhead, audit fees, INQUA 2027 and secretarial assistant etc. aggregating to Rs.5,45,39,435/- as on 31.03.2024. This is a change in accounting treatment as compared to the previous year where these expenses were accounted for on cash basis. Thus, the expenses have been overstated to the extent of Rs. 5.45 crores in the current year on account of change in accounting policy as compared to the previous year and the liabilities have also been overstated by the corresponding amount.
3. BSIP receives grants for various projects for research work undertaken by the scholars and scientists. The grant is utilized for expenses related to that project. However, as on 31.03.2024 we noticed debit balances in the following project grants i.e., excess expenditure over the quantum of grant pertaining to the following grants: -

S. No.	Project	Debit Balance as on 31.03.2024
1.	Dr. Trina Bose - Research Training - Bihar Forest Dept.	1,53,040/-
2.	DST Project - Dr. Manoj M.C.	21,277/-
3.	Indo Sri Lankan Project - Dr. Neerja Jha	25,814/-
4.	MOES Project - Dr. Pauline Sabina	1,82,741/-
5.	NHMS/CHEA Project - Dr. P. S. Ranhotra	76,383/-
6.	NPD Project - Dr. Rajesh Agnihotri	1,428/-
Total		4,60,683/-

We are of the opinion that proper control deserves to be exercised in charging expenses to any grant account.



4. The Bank Reconciliation Statement pertaining to account no. 187301000001666 maintained with Indian Overseas Bank, University Road Branch, Lucknow as on 31.03.2024 contains several very old entries pending reconciliation pertaining to many previous financial years. We are of the opinion that necessary steps to streamline the process and for proper reconciliation of these entries need to be taken by BSIP forthwith.
5. Advances given to the below mentioned parties many years ago are pending for recovery/ adjustment as on 31.03.2024.

Particulars	Year	Amount (in Rs.)	Remarks
M/s Alliance Book Suppliers, Delhi	2014-15	2,00,883.89	The amount is pending since F.Y. 2014-15 and needs to be adjusted appropriately.
M/s Spem A/c	Several Years	55,324.00	BSIP has sent a letter for cancellation of misplaced Demand Draft to Indian Overseas Bank. However, the same is not resolved.

We are of the opinion that necessary steps to streamline the process and for proper reconciliation of these entries need to be taken by BSIP forthwith.

6. Old outstanding balances as on 31.03.2024 in the Advances to Staff are pending since 2017-18. Necessary steps for the recovery/ adjustment from salary needs to be done:

Particulars	Year	Amount (in Rs.)
Mrs. Kirti Singh	2017-18 to 2020-21	3,450/-

7. On scrutiny of the Fixed Assets registers we observed that maintenance & updation 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. Also, RFID tagging is recommended in such situation to proper internal control.
8. The internal control over deduction of Income Tax TDS / GST-TDS and other statutory dues needs to be strengthening to avoid the statutory penalty.
9. BSIP has received COVID Fund Grant of Rs. 1.71 crores in the previous years out of which Rs. 88.91 lacs was unspent (along with accrued interest) has still not been refunded. As per the records provided to us and explanation given to us, we have learnt that correspondence for refund had been made with the Fund issuing authority, the DM



Lucknow; however, the same is not resolved yet. The said amount of Rs. 88.91 lacs is classified under the head -'Advances Received - COVID Management' of Schedule 7 - 'Current Liabilities and Provisions' in the Balance Sheet as on 31.03.2024. However, a FDRs against the said amount has been made during the FY 2023-24, it needs to be refunded to the funding agency.

10. The internal control over loans and advances is not adequate. There should be a process of periodic reconciliation / settlement of the advances. During our verification, it was noticed that properly settlement of pending advances needs to be done periodically.
11. The internal control over issuance of consultancy invoices is not adequate. There should be a mechanism to issue the consultancy invoices centrally and proper reporting of the same should be made with GST /GSTTDS/Income Tax TDS. Proper records should also be maintained and reconciled periodically. The lab wise consultancy invoices process of procurement and maintenance of lab records regarding consumption of chemicals and other consumables needs strengthening.

For Madhur Jain & Co.
Chartered Accountants
Firm Reg. No.: 004865C

Sd/-
Madhur Jain, FCA (Partner)
M. No.: 073699
Date: 03-09-2024
Place: Lucknow
UDIN: 24073699BKBNHB7111



Action Taken Report for the F.Y. 2023-24

Audit Observation	Action taken
<p>1. As per para 8 of the Schedule 24 - 'Significant Accounting Policies' annexed to the financial statements it is stated that retirement benefits and leave encashment have been accounted for on cash basis. However, we have noticed that provision for pension payable to the tune of Rs. 98.15 lacs has been created on 31.03.2024. Thus, the accounting treatment is contrary to the accounting policy mentioned above.</p>	<p>The amount of Rs. 98.15 lacs is advanced drawn for payment of Pension for the month of March 2024 and it is not a provision in true sense. This has been done as per the SOP of PFMS TSA for charging the Salary and Pension & retirement benefits for the month of March 2024 and to be paid in the next month.</p>
<p>2. As per Schedule 7 - 'Current Liabilities and Provisions', provisions have been created for various expenses related to salary, pension, retirement benefits, project overhead, audit fees, INQUA 2027 and secretarial assistant aggregating to Rs. 5,45,39,435/- as on 31.03.2024. This is a change in accounting treatment as compared to the previous year where these expenses were accounted for on cash basis. Thus, the expenses have been overstated to the extent of Rs. 5.45 crores in the current year on account of change in accounting policy as compared to the previous year and the liabilities have also been overstated by the corresponding amount.</p>	<p>The amount of Rs. 5,45,39,435/- consist of following:</p> <ol style="list-style-type: none"> 1- Provision for Overhead (Project) 2- Fellowship payable 3- Workshop Dr. Niraj Rai 4- Professional Charges Payable (Audit Fee Project) 5- Interest Refundable (Building Fund) 6- Remittances (Salary) 7- Pension Payable 8- Retirement Benefit Payable 9- Plan RTF Payable 10- Salary Payable 11- Project Overhead Payable 12- Provision for INQUA 2027 13- Secretarial Assistance Payable <p>As stated above, the advances for Salary, Pension & Retirement benefits have been drawn as per the past practices / SOP of PFMS TSA. The advances from project for project overhead and audit fees has been drawn to reflect the expenditure in the financial year 2023-24. So that true picture could be shown in the Utilization certificate for the FY 2023-24.</p>
<p>3. BSIP receives grants for various projects for research work undertaken by the scholars and scientists. The grant is utilized for expenses related to that project. However, as on 31.03.2024 we noticed debit balances in the following project grants i.e., excess expenditure over the quantum of grant pertaining to the following grants: -</p>	<p>The excess amount shown have been correctly reflected in the UC's of the funding agency has been requested for recoupment of the same. All expenses are incurred in the interest of projects. However, the remedial actions will be taken in current financial year 2024-25.</p>

S. No.	Project	Debit Balance as on 31.03.2024
1.	Dr. Trina - Research Training - Bihar Forest Dept.	1,53,040/-
2.	DST Project Dr. Manoj M.C.	21,277/-
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Noted for compliance.

5. Advances given to the below mentioned parties many years ago are pending for recovery / adjustment as on 31.03.2024.

- (i) The amount of Rs.2,00,833.89 of M/s. Alliance Book Suppliers has already been submitted for consideration of Governing Body.
- (ii) The issue (M/s Spem Rs. 55324/-) is being pursued with the bank.

Particulars	Year	Amount (in Rs.)	Remarks
M/s Alliance Book Suppliers, Delhi	2014-15	2,00,883.89	The amount is pending since F.Y. 2014-15 and needs to be adjusted appropriately.
M/s Spem A/c	Several Years	55,324.00	BSIP has sent a letter for cancellation of misplaced Demand Draft to Indian Overseas Bank. However, the same is not resolved.

We are of the opinion that necessary steps to streamline the process and for proper reconciliation of these entries need to be taken by BSIP forthwith.



6. Old outstanding balances as on 31.03.2024 in the Advances to Staff are pending since 2017-18. Necessary steps for the recovery/ adjustment from salary needs to be done:

The advance of Rs. 3,450.00 pertains to advance payment of Group Insurance Scheme of Mrs. Kirti Singh, was not attending the office and her salary bill of for several month are yet to be paid. The amount will be settled on the payment of salary to her.

Particulars	Year	Amount (in Rs.)
Mrs. Kirti Singh	2017-18 to 2020-21	3,450/-

7. On scrutiny of the Fixed Assets registers we observed that maintenance & updation 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. Also, RFID tagging is recommended in such situation to proper internal control.

Noted for compliance.

8. The internal control over deduction of Income Tax TDS / GST-TDS and other statutory dues needs to be strengthening to avoid the statutory penalty.

Noted for compliance.

9. BSIP had received COVID Fund Grant of Rs. 1.71 crores in the previous years out of which Rs. 88.91 lacs was unspent (along with accrued interest) has still not been refunded. As per the records provided to us and explanation given to us, we have learnt that correspondence for refund had been made with the Fund issuing authority, the DM Lucknow; however, the same is not resolved yet. The said amount of Rs. 88.91 lacs is classified under the head – ‘Advances Received–COVID Management’ of Schedule 7 – ‘Current Liabilities and Provisions’ in the Balance Sheet as on 31.03.2024. However, a FDRs against the said amount has been made during the FY 2023-24, it needs to be refunded to the funding agency.

The unspent amount of Covid grant could not be remitted back to the state government for want of Account number and IFSC Code. However, the issue is constantly being pursued with the funding authorities.



10. The internal control over loans and advances is not adequate. There should be a process of periodic reconciliation / settlement of the advances. During our verification, it was noticed that properly settlement of pending advances needs to be done periodically.	Noted for compliance.
11. The internal control over issuance of consultancy invoices is not adequate. There should be a mechanism to issue the consultancy invoices centrally and proper reporting of the same should be made with GST/GST-TDS/ Income Tax TDS. Proper records should also be maintained and reconciled periodically. The lab wise consultancy invoices process of procurement and maintenance of lab records regarding consumption of chemicals and other consumables needs strengthening.	Noted for compliance.

Sd/-
(Ashutosh Shukla)
Accounts Officer

Sd/-
(Sandeep Kumar Shivhare)
Registrar

Sd/-
(Prof. Mahesh G. Thakkar)
Director



Balance Sheet as on 31.03.2024

(Amount in Rs.)

Particulars	Schedule No.	Current Year	Previous Year
		31.03.2024	31.03.2023
<u>CORPUS/CAPITAL FUND AND LIABILITIES</u>			
Corpus / Capital Fund	1	1,44,08,28,972.07	1,00,10,54,630.16
Reserves and Surplus	2	7,85,93,927.00	7,52,77,980.00
Earmarked / Endowment Funds	3	1,02,78,71,251.51	87,04,45,576.63
Secured Loans and Borrowings	4	-	-
Unsecured Loans and Borrowings	5	-	-
Deferred Credit Liabilities	6	-	-
Current Liabilities and Provisions	7	8,07,22,072.38	7,03,49,522.38
Total		2,62,80,16,222.96	2,01,71,27,709.17
<u>ASSETS</u>			
Fixed Assets	8	30,01,07,728.46	25,97,67,366.00
Investments from Earmarked / Endowment Funds	9	1,02,78,71,251.51	87,04,45,576.63
Investments - Others	10	12,93,01,733.00	11,15,57,859.00
Current Assets, Loans & Advances	11	1,17,07,35,509.99	77,53,56,907.54
Miscellaneous Expenditure (to the extent not written off or adjusted)		-	-
Total		2,62,80,16,222.96	2,01,71,27,709.17
Significant Accounting Policies	24		
Contingent Liabilities and Notes on Accounts	25		

For Madhur Jain & Company
Chartered Accountants

Sd/-
Madhur Jain, FCA
(Partner)

Sd/-
(Ashutosh Shukla)
Accounts Officer

Sd/-
(Sandeep Kumar Shivhare)
Registrar

Sd/-
(Prof. Mahesh G. Thakkar)
Director



Income And Expenditure Account for the period/year ended 31.03.2024

(Amount in Rs.)

Particulars	Schedule No.	Current Year	Previous Year
		2023-24	2022-23
<u>INCOME</u>			
Income from Sales / Services	12	22,17,971.00	8,72,873.88
Grants/subsidies (OB, Deposit A/C and Transfer from Cap. Fund)	13	1,03,00,61,005.77	87,08,49,039.50
Fees/Subscriptions	14	-	-
Income from Investments (Income on Invest. From Earmarked/Endow. Funds transferred to Funds)	15	5,72,43,137.00	4,40,48,231.00
Income from Royalty, Publication etc.	16	-	-
Interest Earned	17	2,81,430.00	3,04,939.00
Other Income/Adjustments	18	34,15,515.34	22,00,977.94
Increase/(decrease)in stock of Finished goods and works-in-progress	19	-	-
Total (A)		1,09,32,19,059.11	91,82,76,061.32
<u>EXPENDITURE</u>			
Establishment Expenses	20	36,44,83,001.00	40,58,03,351.00
Other Administrative Expenses etc.	21	10,15,07,567.62	8,52,50,079.12
Expenditure on Grants, Subsidies etc.	22	-	-
Interest	23	-	-
Depreciation (Net Total at the year-end-corresponding to Schedule 8)		5,21,39,238.58	4,43,60,870.19
Total (B)		51,81,29,807.20	53,54,14,300.31
Balance being excess of Income over Expenditure (A-B)		57,50,89,251.91	38,28,61,761.01
Interest Earned on Reserve Fund		33,15,947.00	20,67,077.00
Interest on GPF Fund transferred to GPF Fund		77,96,602.00	40,64,714.00
Interest on Institute Account refundable to DST		-	-
Interest on Pension Fund Transferred to Pension Fund		4,46,60,951.00	3,26,71,088.00
Interest on Building Fund FD transferred to Building Fund		-	25,91,936.00
Interest on Donated Fund FD transferred to Donated Fund		71,410.00	68,960.00
Transfer to Pension Fund		7,94,70,000.00	5,10,00,000.00
Balance being Surplus / Deficit carried to Corpus / Capital Fund		43,97,74,341.91	29,03,97,986.01
Significant Accounting Policies	24		
Contingent Liabilities and Notes on Accounts	25		



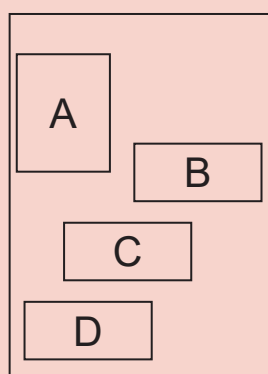
Receipt & Payment Account for the year ended 31.03.2024

(Amount in Rs.)

Receipts	Current Year 2023-24	Previous Year 2022-23	Payments	Current Year 2023-24	Previous Year 2022-23
I. Opening Balances			I. Establishment Expenses		
a) Cash in hand	-	-	a) Salaries and Wages	11,70,30,732.00	13,07,59,558.00
b) Bank Balances:-			b) Allowances and Bonus	9,08,79,720.00	8,81,18,314.00
- In Saving Accounts	10,39,03,414.79	20,29,65,211.54	c) Contribution to CPF (Employer's Contribution)	1,65,68,231.00	2,50,45,183.00
II. Income from Sale & Services			d) Contribution to Other Funds	-	-
a) Income from Sales	-	-	e) Staff Welfare Expenses	-	-
b) Income from Services	22,17,971.00	8,72,873.88	f) Expenses on Employee's Retirement and Terminal Benefits	14,00,04,318.00	16,18,80,296.00
III. Grant & Subsidy			g) Others (specify)	-	-
a) Central Government	68,46,61,005.77	67,56,49,039.50	II. Other Administrative Expenses etc.		
b) State Government	-	-	III. Addition in Fixed Assets		
c) New Building Grant	34,54,00,000.00	19,52,00,000.00	(As per Schedule - 8)	9,24,79,601.04	5,28,64,210.50
IV. Fee & Subscriptions			IV. Increase in Investments from Earmarked / Endowment Funds	15,74,25,674.88	10,13,40,190.00
V. Income from Investment			V. Increase in Investments Others	-	-
a) Interest	5,72,43,137.00	4,40,48,231.00	VI. Increase in Current Assets	41,26,45,925.75	42,18,37,574.99
b) Dividends / Rent / Others	-	-	VII. Decrease in Current Liabilities	-	-
VI. Income from Royalty, Publication etc.			VIII. Transfer to Designated Funds		
VII. Interest Earned			a) Interest on GPF Fund transferred to GPF Fund	77,96,602.00	40,64,714.00
a) On Term Deposit	-	-	b) Interest on Institute Account refundable to DST	-	-
b) On Saving Deposit	-	-	c) Interest on Pension Fund Transferred to Pension Fund	4,46,60,951.00	3,26,71,088.00
b) On Loan	2,81,430.00	3,04,939.00	d) Interest on Building Fund FD transferred to Building Fund	-	25,91,936.00
b) Interest on Debtors & Other Receivable	-	-	e) Interest on Donated Fund FD transferred to Donated Fund	71,410.00	68,960.00
VIII. Other Income & Adjustments	34,15,515.34	22,00,977.94	f) Transfer to Pension Fund	7,94,70,000.00	5,10,00,000.00
IX. Increase in Funds	15,74,25,674.88	10,13,40,190.00	IX. Closing Balances		
(As per Schedule - 3)			a) Cash in hand	-	-
X. Increase in Current Liabilities			b) Bank Balances:-	-	-
(As per Schedule - 7)	1,03,72,550.00	2,64,53,205.54	- In Saving Accounts	8,66,36,091.49	10,39,03,414.79
XI. Decrease in Investments Others	(1,77,43,874.00)	1,23,60,850.00			
Total	1,34,71,76,824.78	1,26,13,95,518.40	Total	1,34,71,76,824.78	1,26,13,95,518.40



Posters: Vigilance Awareness Week - 2023



Description of figures on the back cover:

- A. Professor Birbal Sahni examining specimens under a Microscope.
- B. Panoramic view of East Antarctica near the Bharati Indian Station in Larsemann Hills.
- C. View of Changla Stream, with Chang La Pass (5360 masl), in the backdrop, Ladakh, North India.
- D. Panoramic view of the Neogene outcrops south of Mata-no-madh, Kachchh Region, Gujarat State, western India.



Photo courtesy: BSIP archives



Photo courtesy: Dr. Pawan Govil



Photo courtesy: Dr. Brijita Phariyal



Photo courtesy: Dr. Vivesh Vir Kapur