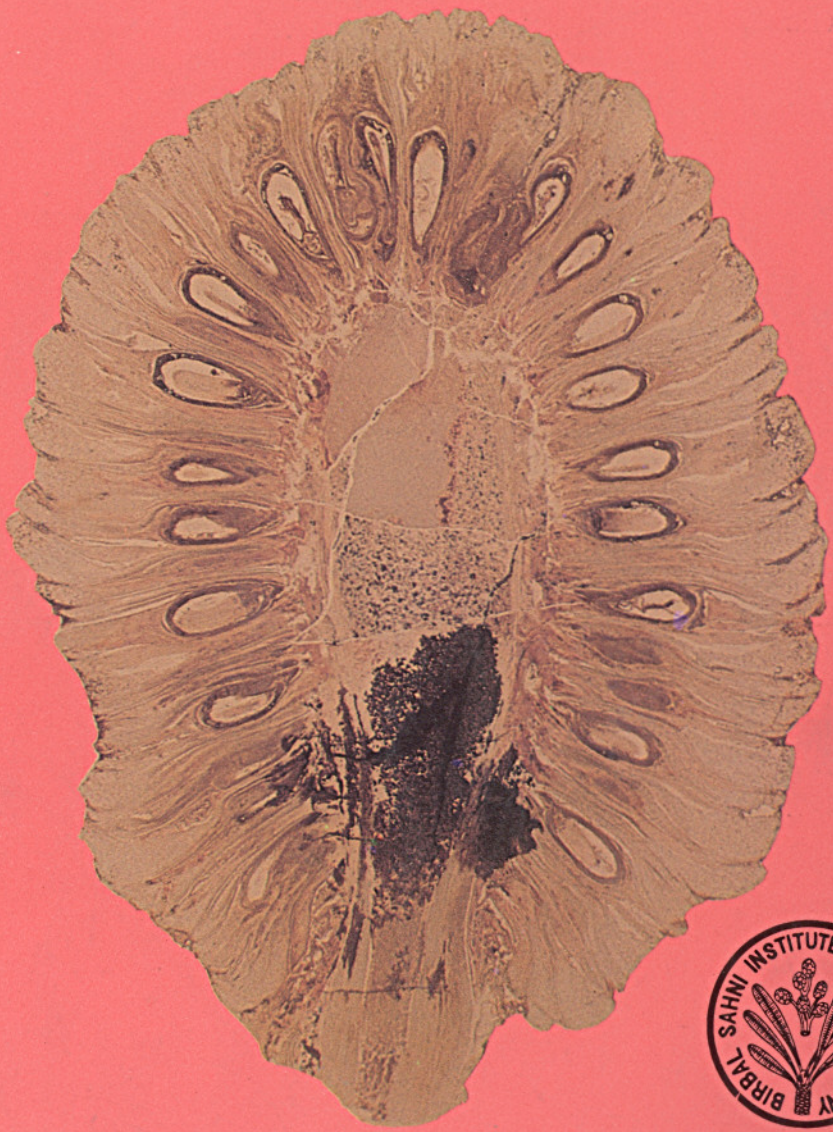
Annual Report

1987-88



BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY
LUCKNOW

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Cover photo : Longitudinal section of a Eocene fossil cone of *Proaraucaria mirabilis* Wieland.

Back Cover photo : Cross section of *Palmoxylon sclerodermum* Sahni from the Early Tertiary Deccan Intertrappean beds of Seoni, Madhya Pradesh.

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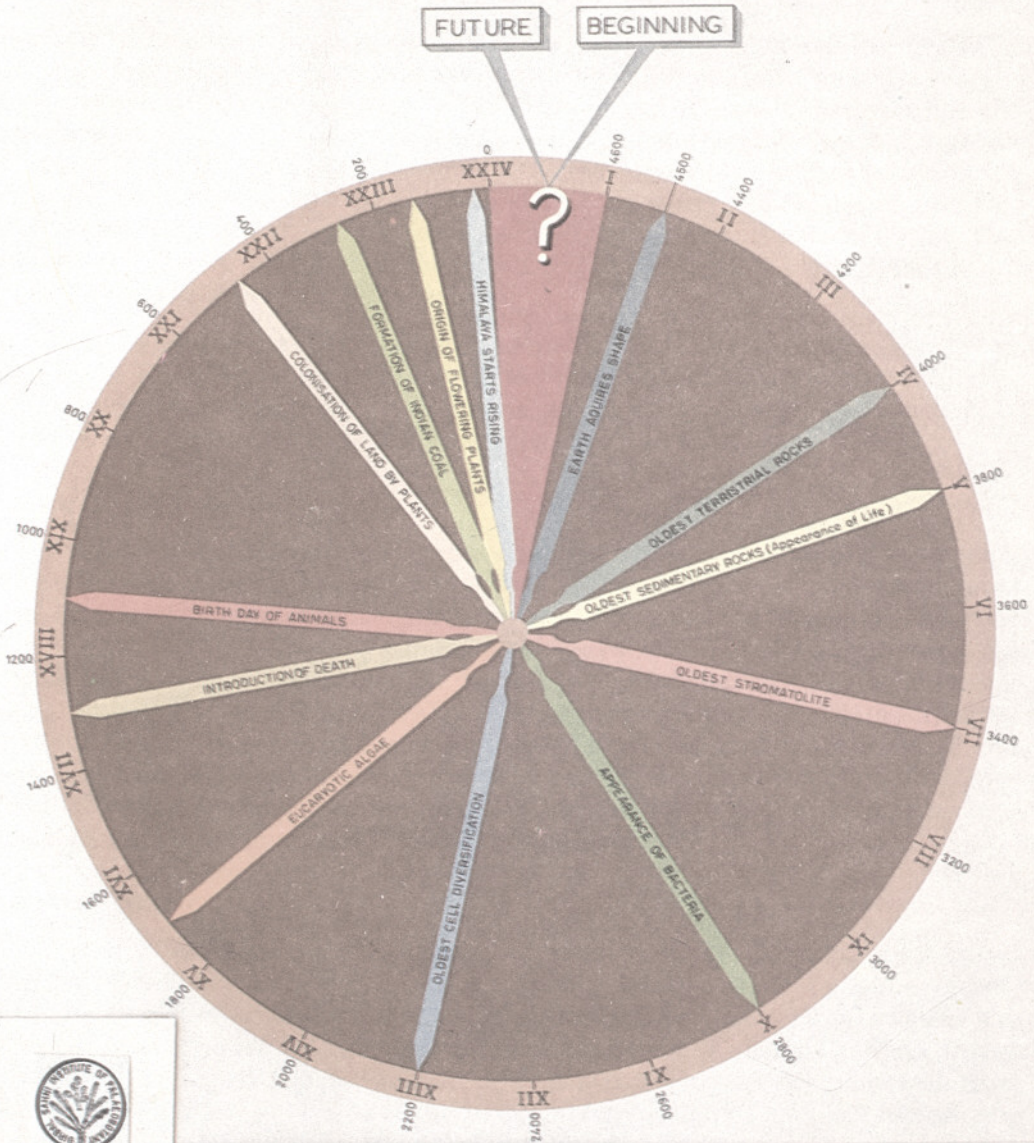
Acknowledgement

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

CONTENTS

GEOLOGICAL CLOCK

IF 4,800 MILLION YEARS = 24 HOURS THEN.



IF LAST 480 CRORE YEARS = 24 hours *THEN*

EARTH AQUIRES SHAPE AT	0. 30 hours	INTRODUCTION OF DEATH AT	17.30 hours
OLDEST TERRESTRIAL ROCKS FORMED AT	04.00 hours	APPEARANCE OF ANIMALS AT	18.30 hours
OLDEST SEDIMENTARY ROCKS FORMED AT	05.00 hours	COLONISATION OF LAND BY PLANTS AT	21.40 hours
FIRST APPEARANCE OF LIFE AT	05.00 hours	FORMATION OF INDIAN COAL AT	22.45 hours
APPEARANCE OF BACTERIA AT	10.00 hours	FLOWERING PLANTS APPEARED AT	23.25 hours
OLDEST CELL DIVERSIFICATION AT	13.00 hours	RISE OF HIMALAYA AT	23.53 hours
FIRST EUKARYOTIC ALGAE AT	15.30 hours	MAN APPEARS AT	23.59.30 hours

Foreword

THE sedimentary rocks of our planet are a treasure-house wherein are entombed evidences related to evolution and development of life forms—in time and space—from a simple biological polymer to modern plants and animals. These evidences are known as fossils. The body fossils of plants may be remains of bacteria, fungi, algae, or of organs of higher plants. The scientists at the Birbal Sahni Institute of Palaeobotany excavate, identify and describe plant fossils to reconstruct whole plants and past vegetations to decipher palaeogeography, palaeoecology and palaeoclimate. This information besides updating the history of the Plant Kingdom helps to locate and explore coal and hydrocarbon resources.

At the Sahni Institute an integrated and multidisciplinary approach is adopted to emphasize synergistic interaction within the institute and collaboration with other organisations—to cover both botanical and geological aspects. A brief summary of achievements made during 1987-1988 academic year follows.

Precambrian—Cambrian

Studies on stromatolites have confirmed occurrence of widespread biogenic activity prior to 2.6 billion years in the Dharwar Craton. Well-preserved mammilated mats of coccoid cyanobacteria have been recorded from the Nauhatta Limestone (Lower Vindhyan). A bilaterally symmetrical coelenterate has been discovered in the Middle Proterozoic Rohtas Formation. Studies on microbiota have indicated that the Arangi Formation (Semri Group) is a lagoonal deposit whereas the Bijaigarh Formation (Kaimur Group) is a littoral deposit. Studies were conducted to understand and distinguish extant contaminants from authentic Precambrian microfossils. The Upper Rewa (Govindgarh) Sandstone has given a F-T age of 700 million years. A glauconite near Chittorgarh has given a F-T age of 1070 million years.

Late Palaeozoic

Cuticular investigation of *Glossopteris* leaves from the Barakar Formation of Raniganj Coalfield has revealed that epidermal features were, to some extent, controlled by local ecology. Characteristic Raniganj leaf fossil *Palaeovittaria* has been reported from the basal Barakar (Karharbari) beds of Raniganj Coalfield. Insect remains belonging to Lepidoptera Group and leaf mining activity of insects have also been observed in the same beds. An indepth analysis of plant megafossil evidence limits the northern margin of the Indian Gondwana along the Indus—Yarlung—Zangbo Suture. Palynological evidence indicates that the Indian mainland Glossopteris Flora had a major impact on Tethyan Himalaya region. The relationship with circum—Tethys realm is limited. Presence of marine influence in Talchir Formation of Gondwana grabens and Talchir to Barakar palynoassemblages from Siang District, Arunachal Pradesh has been inferred. The fresh-water lakes during Permian—Triassic transition period experienced low oxygen supply as is evidenced by the pyritic degradation of spore/pollen exines and decaying organic matter with

finely disseminated particles. Extension of Kamthi sediments indicating presence of additional coal reserves has been proved in southern extension of Kothagudem and Mailaram areas of Godavari Graben.

Mesozoic

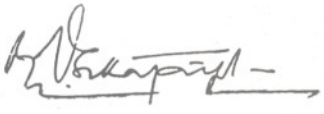
Based on a comprehensive analysis and synthesis of data, 12 assemblage zones and their relative ages have been established in Mesozoic flora of India. Some of these zones extended into neighbouring regions in Pakistan, Nepal, Bhutan and Sri Lanka. Occurrence of fertile organs of water fern *Azolla* in Lameta Group (Maestrichtian) at Dongargaon, Maharashtra indicates lacustrine deposition. Subsurface sequences in Palar, Krishna-Godavari and Cauvery basins have been dated as Hauterivian—Barremian on the basis of contained dinocysts. Aptian-Albian nannoplankton have been recovered from the black shale near Habur, Rajasthan. Five oceanographic events have been traced in the Kuldhar Member of Jaisalmer Formation on the basis of nannofloral and other evidences.

Cenozoic

Occurrence of sapotaceous and fabaceous woods in the Neogene of Kerala Coast traces back the history of Western Ghat flora to Middle Miocene. Record of the genus *Koompassia* (Fabaceae) from the Tipam Sandstone of north-east India provides further evidence of migration of Malayan elements into India during Neogene. Evidence supporting the existence of evergreen tidal forest in the vicinity of Bharuch during the Neogene has been unearthed. Wood resembling that of the African genus *Entandrophragma* (Meliaceae) has been identified in the Neogene sediments near Jaisalmer. Pollen, referable to families Bombacaceae, Anonaceae, Gonystylaceae, Gunneraceae, Clusiaceae, Olacaceae, Caesalpiniaceae and others commonly found in Palaeocene—Eocene sediments reflect presence of a tropical, evergreen rain-forest and associated habitats. Occurrence of *Thalassiphora* and other palynofossils in the Kakra assemblage (Punjab Basin) is indicative of nearshore deposits of Lower Eocene age. Occurrence of *Ceratopteris* spores has been traced as far back as Eocene in Meghalaya. Palynofossils recovered from Red Bed facies of Dagshai Formation near Garkhal, Himachal Pradesh suggest that the sequence may be representing the Subathu Formation. The Siwalik sediments from Bagh Rao, Uttar Pradesh contain a palynoflora that suggests fresh-water swamp deposits of Upper Miocene age. Fresh-water swampy elements have also been found in the Siwalik of Arjunkhola, Nepal. Palynological data from Ratnagiri lignites have been interpreted to show deposition under deltaic to near-shore conditions in a tropical-humid climate. Two new exposures of this lignite have been discovered. The Eocene—Lower Miocene sediments represented in the Aruthangal bore-hole (Kerala) were deposited in marginal marine conditions supporting mangrove swamps all along the coast. The lignite in III Neyveli Mine Area was formed of terrestrial angiospermic vegetation deposited in a broad coastal setup in warm-humid conditions. Alginite (*Botryococcus*) has been recorded for the first time in Indian Tertiary coals and lignites.

A mixed Chirpine-Oak vegetation has been palynologically recorded in bottom sediments of 3 lakes in Kumaon. About 2,000 years old sediments from the western flank of Chilka Lake, Orissa contain pollen of some mangrove plants indicating

existence of a mangrove forest in the area. The Chilka Lake profile has given a radiocarbon date of 1,620 years B.P. at a depth of 2.65 m. The sedimentation rate derived at this depth is 10 cm/100 years. Indications of aridity phases during Holocene at 18,000 years glacial maximum have been found at several localities in Haryana and at Faizabad. Fruit shells of walnut and almond have been found in archaeological samples. Carbonised seeds and fruits recovered from Late Harappan samples from Hulas, Saharanpur District, Uttar Pradesh suggest that the settlers practiced advanced agriculture circa 2,000-1,200 B.C. Investigations show that some plants of medicinal value were known to Vedic Indians of Hulaskhera, Lucknow District and of Ghaghra Valley.



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Krishna P. Jain	. Secretary, Indian Association of Palynostratigraphers
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Hafiz A. Khan	. Executive Member, Palynological Society of India
	. Editor, Indian Journal of Bio-Research, Lucknow
Hari K. Maheshwari	. Member, Committee for Fossil Plants, International Association for Plant Taxonomy
	. Editor, The Palaeobotanist
	. Editor, Indian Association of Palynostratigraphers
	. Secretary, Organising Committee, Workshop on : Concepts, limits and extension of the Indian Gondwana
	. Member, Organising Committee, Symposium on : Vistas in Indian Palaeobotany

Prabhat K. Maithy	. Member, Editorial Board, Geoviews
	. Member, Executive Council, The Palaeobotanical Society (till 31st December, 1987)
	. Joint Secretary, Organising Committee, VII Indian Geophytological Conference
Jagannath P. Mandal	. Assistant Editor, Vanaspatik Club, Lucknow
Basant K. Misra	. Member, Editorial Board, Indian Society of Geoscientists
Garud K. B. Navale	. Member, Editorial Board, International Journal of Coal Geology
	. Member, International Committee of Coal Petrology
	. Member, International Commission of Coal Nomenclature and Analysis
	. Vice-President, Coal Petrological Society of India
	. Member, Indian Standards Institution (Coal)
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Govindraja Rajagopalan	. Member, Executive Council, Indian Society of Geoscientists
	. Member, Advisory Committee, Regional Sophisticated Instrumentation Centre, Lucknow
	. Member, Academic Committee of School of Archaeological Dating, Jadavpur University, Calcutta
Ramesh K. Saxena	. Secretary, Indian Society of Geoscientists
	. Member, Editorial Board, Indian Society of Geoscientists
Jaswant Singh	. Editor, 'Geophytology'
Hari P. Singh	. Secretary, The Palaeobotanical Society
	. Secretary, VII Indian Geophytological Conference
	. Editor, The Palaeobotanist
	. Member, Editorial Board, Geophytology
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Jagdish C. Srivastava	. Secretary, Society for Conservation of Nature and Scientific Development

Shyam C. Srivastava	. Councillor, Indian Society of Geoscientists
Sukh-Dev	. Treasurer, The Palaeobotanical Society
	. Member, Editorial Board, Geophytology
Ram S. Tiwari	. Chief Editor, Vanaspatik Club Newsletter
	. Editor, The Palaeobotanist
	. Member, Executive Council, The Palaeontological Society
	. Member, Managing Council, Indian Association of Palynostratigraphers
	. Vice-President, International Association of Applied Biology
	. Member, Advisory Committee for Science Programme, All India Radio
	. Joint Secretary, The Palaeobotanical Society
Archana Tripathi	. Member, Executive Council, The Palaeobotanical Society
Surya K. M. Tripathi	. Joint Secretary, Indian Society of Geoscientists
B. S. Venkatachala	. Chief Editor, The Palaeobotanist
	. President, The Palaeobotanical Society
	. Chairman, Organising Committee, Workshop on : Concepts, limits and extension of the Indian Gondwana
	. Convener and Chairman, Symposium on: Tropical Tertiary Palynology, VII International Palynological Congress, Brisbane, Australia
	. Chairman, Coal & Ground Water Resources Section, Diamond Jubilee National Symposium on: Development of India's Mineral and Fuel Resources, Geological and Environmental Aspects, Indian School of Mines, Dhanbad
	. Chairman, Expert Committee, Centre for Palaeoclimatic and Environmental Research (PERCA)
	. Member, Committee for Fossil Plants, International Association for Plant Taxonomy
	. Member, Expert Group, International Symposium on : Evolution of Man and Society in India, Indian Academy of Social Sciences, New Delhi

Honours and Awards

N. Awasthi	.	Elected "Fellow"—Indian Association of Palynostratigraphers
H. P. Gupta	.	Elected "Fellow"—Indian Association of Palynostratigraphers
C. M. Nautiyal	.	Best paper in Earth, Planetary Science and Petroleum Exploration section of the IV National Symposium on Mass Spectrometry, Bangalore
Anand Prakash	.	Elected "Fellow"—Indian Association of Palynostratigraphers
Suresh C. Srivastava	.	Elected "Fellow"—Indian Association of Palynostratigraphers

Research

Project I.D.1 : **Palaeobiology of Precambrian—Cambrian sediments of India**

Objective : *Search for Precambrian biota and tie-up with radiometric dates based on glauconite; establishment of evolutionary chronology*

Subproject I.D.1.1 : **Palaeobiology and stratigraphy of Vindhyan sediments in Son Valley and Rajasthan**

Objective : *Search for the evidence of Vindhyan life and its role in mineralisation*

The Kajrahat Limestone has two distinct lithological facies, the basal calcareous and top dolomitic. Microbiota is totally absent in the calcareous portion, though the stromatolites are present in abundance. Contrary to this the dolomitic facies has poorly preserved single spherical cells, groups of spherical cells and tubular filamentous forms. The carbonaceous facies of Arangi Formation contain elongate tubular forms and spherical cells while from the Bijaigarh Formation only distorted acritarchs are recorded. These indicate different environments of deposition.

In the Semri sequence of the Chittorgarh-Neemuch area only the shale facies is fossiliferous. The poor preservation of microbiota is due to presence of intense folds and steep dips in the area.

Pteridium simplex Gurich, a coelentrate is reported for the first time from the Rohtas Formation. The presence of bilateral symmetry in eumetazoan indicates an organisation advantageous for active food gathering habit.

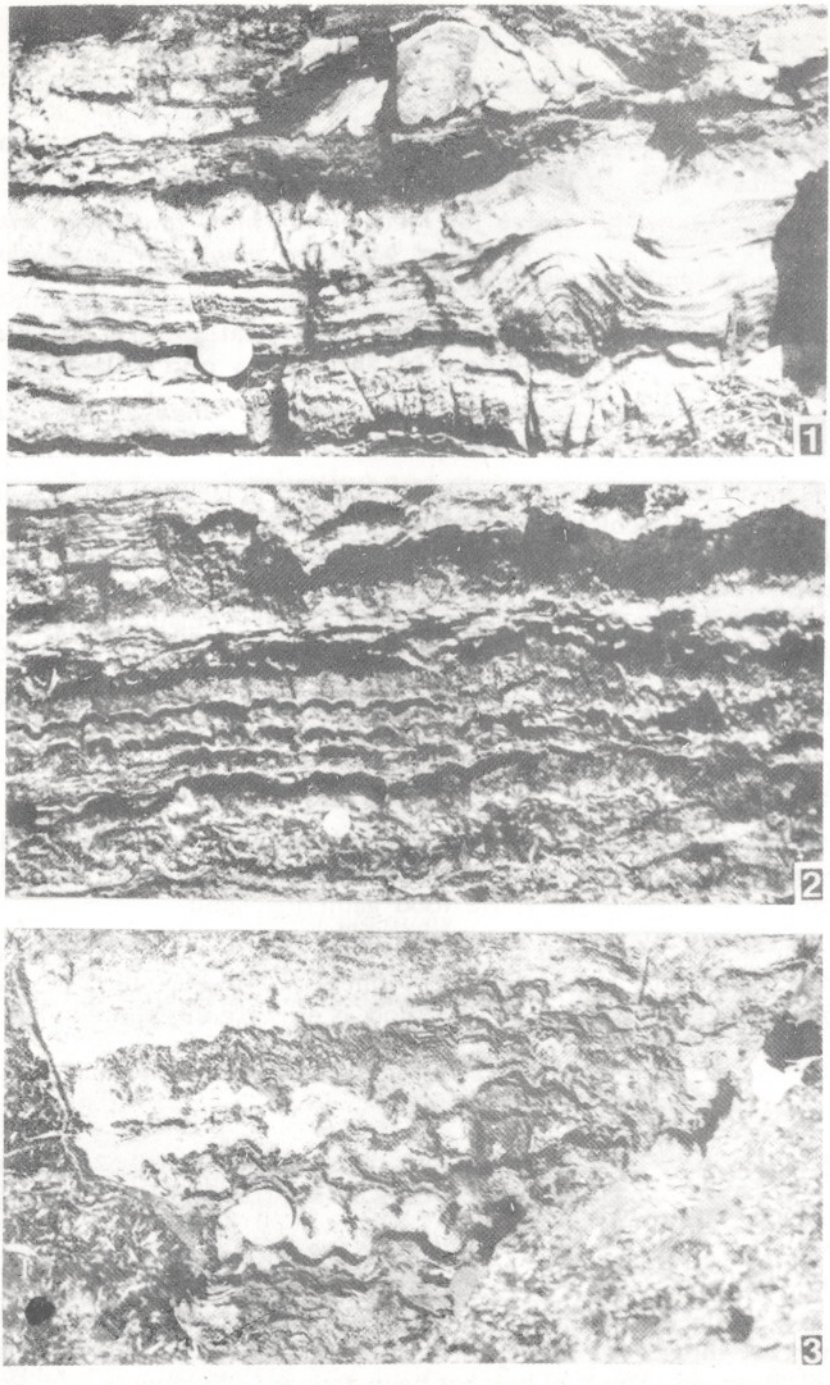
A new form of stromatolites showing primary, secondary and tertiary branchings is recorded from the Upper Bhander Limestone of Phalodi. The matrix of stromatolites being calcareous, no microbiota is preserved in between laminations.

P. K. Maithy, Rupendra Babu and K. L. Meena

Subproject I.D.1.2 : **Biological remains from Precambrian sequence of Kumaon and Garhwal Himalaya**

Objective : *To decipher evolution and diversification of life forms during the Precambrian*

The Lesser Himalaya zone, south of the central crystalline axis and north of the main boundary thrust, is made up of thick sedimentaries including Larji-Deoban, Shali, Krol, Buxa, etc. The Krol belt has been assigned age ranging from Palaeozoic to Mesozoic. However, recent studies of isotopic composition of the carbonates have indicated Precambrian age for the Krol sediments. Studies on the thin sections of dark coloured cherts from Infra Krols have shown the presence of cyanobacteria,



Archaean stromatolites from Shimoga Schist Belt, Dharwar Craton (> 2.6 billion years): 1. Domal structures, 2. Stratified mats, and 3. Pseudo-columnar structures.

viz., *Palaeoanacystis, Gunflintia, Eomycetopsis, Huroniospora* and *Eosphaera*, etc. This assemblage compares with the other Late Precambrian microbiotic assemblages of the world.

Manoj Shukla (and S. K. Acharyya, GSI)

Subproject I.D.1.4 : **Fission-Track dating of glauconite from the Vindhyan sediments**

Objective : *Dating and correlation of Vindhyan sediments in Son Valley and Rajasthan*

F-T ages of the glauconitic sandstone bed exposed around Rawatbhata area, SE Rajasthan range from 675 to 710 Ma with 15% statistical error. The comparison of these F-T results with that of the eastern part of Vindhyan Basin indicates that this bed may belong to Upper Rewa Formation.

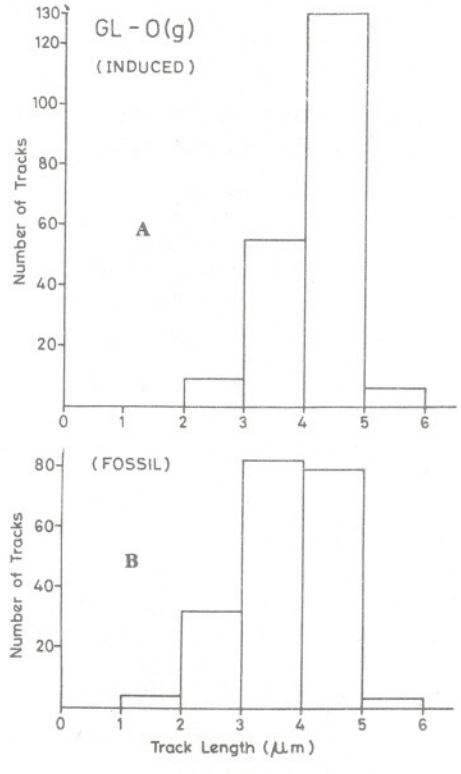


Figure 1—A. Distribution of lengths of fossil fission tracks produced by the spontaneous fission of ^{238}U atoms; **B.** Distribution of lengths of induced fission-tracks of ^{235}U atoms by thermal neutron bombardment.

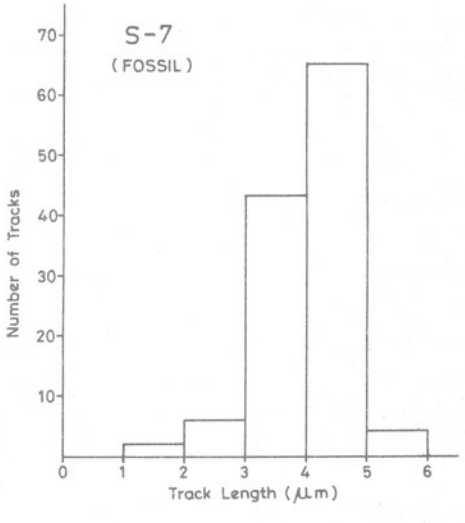


Figure 2—Graph showing the measured track length distribution of—120 fossil fission tracks revealed on glauconite grains separated from sample S-7 of Lower Vindhyan sandstone exposed at Sangrampur, Chitrakut. Comparison of track length distribution of G1-O(g) and S-7 clearly indicates that the latter has not been disturbed by any post depositional thermal annealing.

Out of the two samples collected from Bodwali, Chittorgarh District, one (dark green) could not be dated due to opacity of glauconitic grains while other has given F-T age of 1070 Ma. This bed correlates with the Kheinjua Formation of Son Valley.

At Chittorgarh base rock of Vindhyan deposit is Bearch granite. F-T dating of this rock has also been taken up to correlate with the age of the base rock of Vindhyan deposits in central India. Few apatite grains could be separated after crushing the Bearch granite sample. The grains of one lot were mounted on teflon pieces and fossil tracks were counted after polishing and etching. The fossil density is obtained as 4.07×10 tracks/cm^2.

G. Rajagopalan and A. P. Srivastava

Project I.D.2 : **Flora and palynostratigraphy of coal and associated sediments of Gondwana grabens and and their genesis**

Objective : *Floristics, phytogeography, palaeoecology, palynostratigraphy, correlation of coal seams and tracing of evolutionary trends*

Subproject I.D.2.1 : **Morphotaxonomy, floristics and biostratigraphy of Lower Gondwana plants in Son Valley**

Objective : *Comparative morphology and floristics*

Plant megafossil assemblages from Gothra Hill, Mahan River Section, Gopad River Section, Kanhai Nala, Tilanga Ghat, Sehra Nala, Burchur River, Chamus Nala, Nidhpur and Jabadhar Nala show preponderance of Raniganj equivalent species. The Nidhpur area hitherto assigned a Middle Triassic age, is now dated as Permian.

Shaila Chandra, A. K. Srivastava and K. J. Singh

Subproject I.D.2.2 : **Palynostratigraphy of the Gondwana sediments in Son Valley**

Objective : *Morphotaxonomy, correlation and age determination*

Samples from Nidpur Bed, Son Basin have yielded palynoassemblages that have helped in building up a sequential picture of palynofloral change from coal-bearing strata to *Dicroidium*-bearing bed. Permian palynofossils in the Nidpur Bed have been recorded. The stratigraphic implications of this find is significant.

R. S. Tiwari and Ram Awatar

Subproject I.D.2.3 : **Classification of coal types, rank determination and investigation of sedimentary organic matter in Son Valley**

Objective : *Genesis and characterization of coal types*

Microscopic study of Umaria coals has revealed characteristic/variable (vitric-mixed-fusic) coal types. On the basis of reflectance studies, the coal has been classified as high volatile bituminous C low rank. The Korar coals, on the other

hand, have more reactive fractions with higher rank revealing good quality coal seams. The coal seam appears to have undergone rapid devolatisation which could be related to thermal metamorphism due to igneous intrusions.

G. K. B. Navale and B. D. Singh

Subproject I.D.2.4 : **Floral succession in the Triassic sediments of Son Valley**

Objective : *Morphotaxonomy, palaeoecology and biostratigraphy*

Triassic seeds from Nidpur exhibit affinity with Pteridospermales, Cycadales and Coniferales. Thirteen new taxa have been proposed on characters of integument, nucellus, megaspore membrane and features of micropylar and chalazal ends. Reconstructions of seeds have been prepared.

Shyam C. Srivastava and S. R. Manik

Stratigraphic position and age of plant-bearing Nidpur beds have been determined on the basis of megafossils and interpretation of palynofossil data. A Triassic age assignment is preferred.

Shyam C. Srivastava

Subproject I.D.2.5 : **Comparative morphology and floristics of Lower Gondwana plants in Damodar and Rajmahal grabens and their significance in evolution and stratigraphy**

Objective : *Floristics, compilation of fossil floras, stratigraphy and evolution*

Fossil insect wings from Permian of India.

Investigations of the Lower Barakar (seams I-IV) flora from Sangramgarh, Dalmia, Palasthali, Gourandih, Raja, Nirsa, New Bagma, Gopinathpur, Lakhimata, Rajpura, Chapapur, Bajna and Khudia collieries of Raniganj Coalfield have been completed. The fossil assemblages are represented by Equisetales, Filicales, Glossopteridales, Cordaitales and large number of isolated seeds, sporangia and scale leaves. A phyllothecan fructification is recorded that is organizationally distinct from the northern phyllothecas.

Insect wings, galls, mines, eggs, trails and burrows have also been discovered in association with plant fossils.

A. K. Srivastava

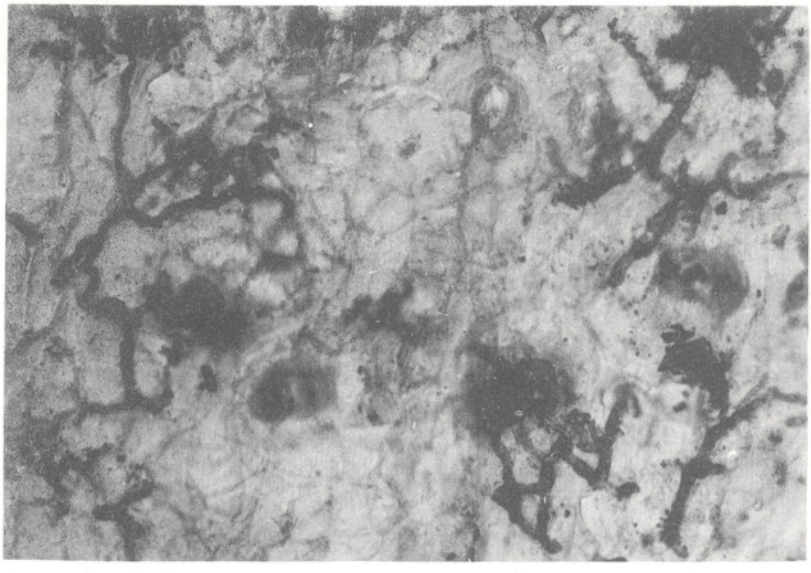
Glossopteris leaves collected from the roof shale of Lohapiti seam of Raniganj Formation in Jharia Coalfield were chemically processed for cuticular preparations. The cuticle is not well-preserved. Under Scanning Electron Microscope it shows rod-shaped structures, particularly on the lateral walls of epidermal cells.

Pyritic inclusions in limonitic wood from the same bed were examined under the SEM to understand the process of their deposition. Framboidal structures have not been observed.

Usha Bajpai and Rajni Tewari

Study of *Glossopteris* species from the Barakar Formation of Churulia area, Raniganj Coalfield has been completed. In all, twenty one species have been described; nine are new. The present study and a review of the past work has

Microthyriaceous stromata on lower cuticle of *Thinnfeldia indica* Feistmantel from the Sivaganga Formation, Tiruchirapalli District.



Fungal hyphae on lower cuticle of *Thinnfeldia indica* Feistmantel from the Sivaganga Formation, Tiruchirapalli District.

provided valuable clues regarding the evolutionary tendencies in *Glossopteris* species. With the help of morphographical and cuticular features ecological conditions under which the genus thrived have been interpreted. It has been observed that cuticular characters taken independently are not reliable enough for circumscription of species, since morphographically similar leaves have yielded different types of cuticle while morphographically dissimilar leaves have yielded same type of cuticle.

Hari K. Maheshwari and Rajni Tewari

Microthyriaceous germlings have been observed on the lower cuticle of a *Glossopteris* leaf from the basal Barakar sediments of Chitra Mine Area, Deogarh Coalfield. Comparative studies have shown presence of microthyriaceous stromata on the lower cuticles of *Thinnfeldia indica* Feistmantel and a leaf apparently of *Ctenozamites* type, both from the Lower Cretaceous of Naicolam, Tiruchirapalli District, Tamil Nadu. *Mycelia sterilia* have also been recorded on the lower cuticle of *Thinnfeldia indica*. On the basis of the occurrence of microthyriaceous fungi, a tropical to subtropical climate is deduced for the Early Cretaceous Period of India.

Usha Bajpai and Hari K. Maheshwari

Subproject I.D.2.6 : **Comparative morphology, floristics and bio-stratigraphy of Lower Gondwana plants in Mahanadi and Pranhita-Godavari grabens**

Objective : *Floristics and compilation of fossil floras, phyto-geography and evolution*

Climatic changes during the Lower Gondwana times in India, particularly during the coal-forming period have been deciphered. The synthesis has been done mainly on the basis of available data on plant characteristics and overall composition of the flora. It is concluded that the climate was essentially temperate. It was very cold during the sedimentation of Talchir rocks and gradually ameliorated in Karharbari, Barakar, Barren Measures and Raniganj periods with increase in humidity and rainfall. Sudden fluctuations of dry and semi-arid conditions were experienced in the deposition of Barren Measures and Kamthi formations which is depicted by the plant types found therein.

Shaila Chandra and Anil Chandra

The Handapa flora shows that there might have been a thick upland vegetation of dense forest. The plants with huge abundant leaves of *Glossopteris* and seasonal falling indicate favourable conditions for plant growth. The forest must have been dominated by *Glossopteris* trees or shrubs (about 80% of the total flora) with small patches of open area for the development of small pteridophytic plants. On the basis of the flora, a warm temperate climate has been inferred.

Shaila Chandra and K. J. Singh

Subproject I.D.2.7 : **Comparative morphology of Lower Gondwana megaspores**

Objective : *Morphotaxonomy, affinity based on comparative studies with modern taxa, biostratigraphical significance*

Permian megaspores from Zaire were chemically processed for study of finer characters of the inner body (Mesosporium). Most of the mesosporia show *Duosporites* type of "Cushions" on the proximal face.

Usha Bajpai

Study of Lower Gondwana megaspore taxa has been completed and their biostratigraphic significance was worked out. It has been observed that while some genera have a wide vertical distribution others are restricted to a particular horizon. Most "Upper Gondwana" megaspores show a restricted distribution.

Hari K. Maheshwari and Rajni Tewari

Subproject I.D.2.8 : **Mesozoic flora from Satpura Graben**

Objective : *Morphotaxonomy, relationship and evolutionary linkages*

A comparative study of the fossil flora from Jabalpur Formation (Jabalpur and Sehora) with the other Mesozoic floras depicts that this assemblage can be assigned to Early Cretaceous. Subtropical to tropical climate is inferred at the time of its deposition.

Sukh-Dev and Neeru Pandya

Subproject I.D.2.9 : **Mesozoic flora from the Mahanadi and Pranhita-Godavari grabens**

Objective : *Systematic study of floral succession and biostratigraphical implications*

The study extends the geographic distribution of *Cycadopteris* from Jabalpur and Rajmahal formations to Athgarh Formation in Orissa. Its presence indicates xeric conditions.

Neeru Pandya

Comparative study of the plant assemblages from Athgarh and Golapalli formations reveals the resemblance of the former assemblage with the Bansa assemblage in having *Gleichenia nordenskioldii, Hausmannia, Phlebopteris* and *Cycadopteris* and that of the latter assemblage with the Sehora Assemblage in general composition of the flora. Both the assemblages are dated Early Cretaceous, the former being younger.

Sukh-Dev and Neeru Pandya

Subproject I.D.2.10 : **Fossil flora of Rajmahal Formation**

Objective : *Morphotaxonomy, floral succession and age determination*

The megafloral assemblage from Dubrajpur Formation at Khatangi Hill, Bihar includes some new taxa, viz., *Culcitites, Onychiopsis, Ctenis, Taeniopteris* and *Pagiophyllum*. The occurrence of *Culcitites* is noteworthy as its distribution in the Indian subcontinent and in Madagascar shows close affinity of the two now separated land floras.

Jayasri Banerji

Subproject I.D.2.11 : **Reconstruction of the *Pentoxylon* plant**

Objective : *Anatomical investigation of Pentoxylon stem, Nipaniophyllum leaf, Sahnia pollen organ and Carnoconites seed-cone for establishing organic relationship*

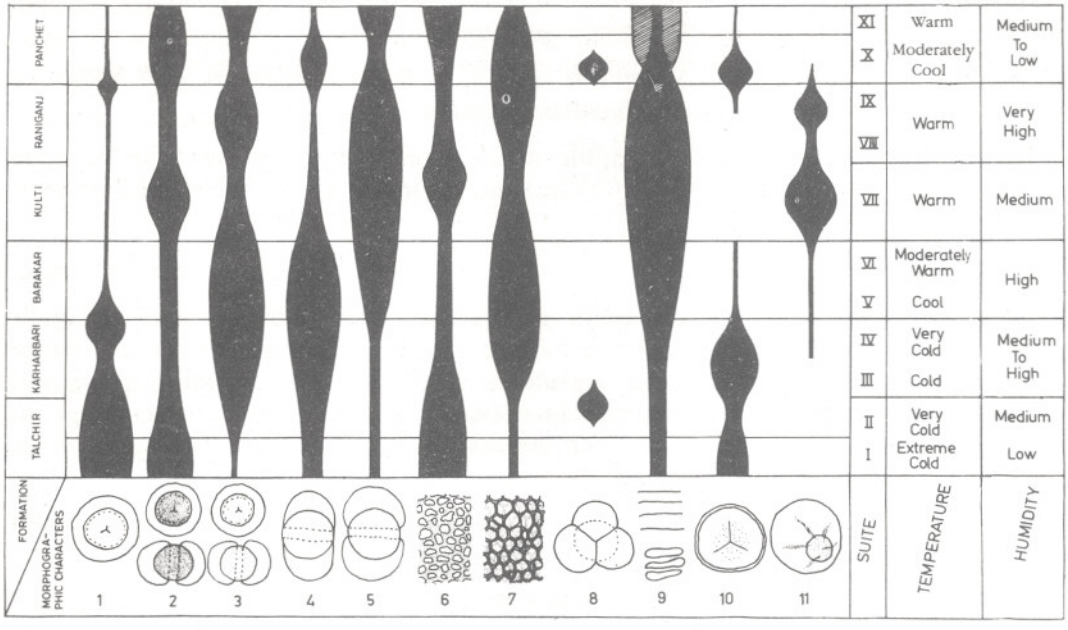
Detached organs of *Pentoxylon* were identified in chert blocks from Nipania. Reconstruction of *Pentoxylon* plant is underway.

Shyam C. Srivastava

Subproject I.D.2.12 : **Palynostratigraphy of Gondwana Sequence in Rajmahal Basin**

Objective : *Palynostratigraphy, biozonation and correlation of coal-bearing horizons*

The quantitative and qualitative estimation at different levels of bore-core RJNE-32 shows a characteristic pattern of palynoflora. The *Striatopodocarpites-Crescentipollenites* assemblage is recorded between 474-381.15 m. From 359.35-353.35 m the flora is rich in *Lunatisporites, Playfordiaspora, Tigrisporites* and other



Trends in the distribution of morphographic characters, considered to be important from Talchir to Lower Panchet, in terms of relative abundance. **1,** Radial monosaccate; **2,** Dense central body; **3,** Thin central body; **4,** Haploxylonoid construction; **5,** Diploxylonoid construction; **6,** Leathery saccus; **7,** Non-leathery saccus; **8,** Tetrad of spores; **9,** Solid black striations and oblique lines: Taeniae; **9,** Solid black striations and oblique lines: Taeniae; **10,** *Callumispora*; and **11,** *Densipollenites.*

Late Triassic elements. At 325 m, the assemblage is rich in *Araucariacites* and has *Gleicheniidites, Murospora, Densoisporites, Contignisporites, Callialasporites* and *Podocarpidites*, etc.

Archana Tripathi

Subproject I.D.2.13 : **Palynostratigraphy of Gondwana Sequence in Damodar Graben**

Objective : *Palynological dating, palynostratigraphy and bio-zonation*

Palynological zones in bore-hole RAD-6 and RAD-7 (Raniganj, Ondal area) have been identified. Raniganj/Panchet boundary is located at 396.10 m in bore-hole RAD-6. In bore-hole RAD-7 only Raniganj palynoflora has been found. Correlation between various bore-holes in this area has been established.

R. S. Tiwari, Vijaya and Kindu L. Meena

Subproject I.D.2.14 : **Palynostratigraphy of Gondwana Sequence in Godavari Graben**

Objective : *Palynostratigraphy, biozonation and correlation of coal-bearing horizons*

Palynological investigation in Ramkrishnapuram area has been continued in bore-hole GRK 25. The data analysed from bore-holes GRK 1 and GJP 1 have been compiled and drafted. The presence of *Leiosphaeridia* in association with *Parasaccites* indicates marine influence in the Talchir Formation. The younger palynozones up to Kamthi Formation have been palynologically established.

Bore-holes GBR 1 and GBR 3 from Budharam area have been studied. Presence of Barakar palynoflora has been demarcated. In bore-hole GBR 3 Lower Kamthi palynoflora is present at 39 m indicating that the thickness of Lower Member of the Kamthi Formation and Barren Measures Formation overlying the Barakar has considerably reduced in Budharam area.

Palynological assemblages worked out so far from the Kamthi Formation in Godavari Graben were grouped in five palynozones, the youngest being dominant in *Densipollenites* + *Striatopodocarpites* indicating Upper Permian affinity. The penultimate assemblage is marked by the dominance of *Parasaccites* indicating a severe cooling phase similar to that inferred for Talchir Formation.

Suresh C. Srivastava and Neerja Jha

Palynoassemblages from Barakar to Kamthi formations have been demarcated in bore-holes GM 3 and GM 4 from Manuguru area. Thus the possibilities of existence of two coal horizons in Manuguru area have been indicated.

Neerja Jha

Subproject I.D.2.15 : **Palynostratigraphy of Palaeozoic and Mesozoic sediments in Mahanadi Basin**

Objective : *Palynostratigraphy and biozonation*

Samples from Brahmini River Section, Talcher Coalfield have been macerated. Poor yield of palynofossils shows impoverished nature of the assemblage.

R. S. Tiwari and Archana Tripathi

Collection made from Athgarh Formation of Mahanadi Basin proved largely unfossiliferous except 2 samples from a bore-core drilled in Talbasta region and 4 surface samples of Birla Fire Clay Mine 'A'. The palynoassemblage consists of *Cyathidites, Todisporites, Matonisporites, Contignisporites, Murospora, Alisporites, Podocarpidites, Araucariacites*, etc.

R. S. Tiwari and B. N. Jana

Subproject I.D.2.16 : **Palynology of Gondwana Sequence in Satpura Basin**

Objective : *Palynostratigraphy, biozonation and correlation of coal-bearing horizons*

Palynological investigation of the samples from south of Pachmarhi shows the dominance of striate disaccate pollen in association with *Densipollenites, Corisaccites* and *Guttulapollenites*. This assemblage compares with that of the Middle Member of Kamthi Formation in Godavari Graben. In Satpura Basin, presence of Upper Permian coal is suspected in the lower part of the Bijori Formation.

Suresh C. Srivastava

Subproject I.D.2.17 : **Critical assessment of coals from Damodar and Rajmahal grabens**

Objective : *Classification of coals and assessment of their quality*

Biopetrological investigations of the coals from Karo, Jargandih, Pipradeeh, Dhori, Kathara, Swang and Angwali blocks of East Bokaro Basin revealed that the coals from Angwali area are comparatively rich in vitrinite contents. The reflectance characteristics of these coals show high volatile B to medium volatile rank.

G. K. B. Navale and R. Saxena

Coals in bore cores HRC-CM/107 and 109 from Hura Coalfield contain variable amount of reactive constituents with occasionally dominant non-reactives and poor sporinites. Some statistical models have been developed for evaluation of the Rajmahal coals.

G. K. B. Navale and B. D. Singh

Subproject I.D.2.18 : **Evaluation and rank assessment of coal seams of Pathakhera Coalfield, Satpura Graben**

Objective : *Coal seam characterization*

On the basis of maceral and microlithotype analyses, the Pathakhera coals have been divided into three types, viz., 1. Vitrinite rich type, 2. Intermediate type, and 3. Inertinite rich type. In general the vitrinite reflectance ranges between 0.6% to 0.9% which suggests that these coals can be grouped with the high volatile bituminous coals.

Anand Prakash and O. S. Sarate

Subproject I.D.2.19 : **Palynostratigraphic studies of Palaeozoic sediments in West Siang District, Arunachal Pradesh**

Objective : *Palynostratigraphy*

The palynological assemblage recovered from the concretions in the Garu Formation is similar to those from the sediments containing them, thus indicating a

A faunal coal-ball containing invertebrate fossils of Sakmarian age (Lower Permian) from Garu Formation, Arunachal Pradesh.

synchronous deposition. It is further inferred that the coal and associated sediments of the Garu Formation are autochthonous in nature and were deposited under marine influence.

Palynoflora recovered from Garu Formation in western Siang shows two distinct assemblages. Older assemblage consists of *Parasaccites* and *Callumispora* in association with *Indotriradites* and *Cabeniasaccites*. Whereas the younger assemblage is dominated by *Scheuringipollenites*. These assemblages are also associated with two distinct assemblages of invertebrate fossils.

Suresh C. Srivastava

Subproject I.D.2.20 : **Palynostratigraphic studies, rank and properties of coal and associated sediments in Eastern Himalaya**

Objective : *Palynological study of coal and associated sediments and petrographic evaluation of coal*

Biozones characteristic of various Lower Gondwana horizons, ranging from Talchir to Raniganj, have been described in detail in the Gondwana of Eastern Himalaya. The status of continental and marine sediments from the Permian Sequence of this region has been discussed in the light of the present concept of Gondwana lithounit.

Eleven coal samples from the Upper Tertiary foot-hill sediments of Arunachal Pradesh have been processed for vitrinite contents.

The palynological assemblages so far recorded from the eastern Himalayan Lower Permian sediments have been grouped into palynozones which are comparable to Talchir-Raniganj assemblage.

Suresh C. Srivastava, Anand Prakash and A. P. Bhattacharyya

Project I.D. 3 : **Floristics, palynostratigraphy and organic petrology of Indian lignites and associated sediments**

Objective : *Comparative morphology of mega- and microfossils and microstructure of lignites, correlation, genesis and depositional environment*

Subproject I.D.3.1 : **Tertiary plant megafossils from Kerala Basin**

Objective : *Morphology, palaeoecology, phytogeography and evolution of modern trees of Western Ghats*

Carbonised woods from the Neogene sediments of Varkala, Padappakara and Payangadi on Kerala coast were studied. Those showing fairly well-preserved tissues have been identified as *Cassia* (Fabaceae), *Palaquium* (Sapotaceae), *Anisoptera* (Dipterocarpaceae) and *Bischofia* (Euphorbiaceae). Additions of these taxa to the Neogene flora of Kerala coast is significant for further consideration of palaeoecology and phytogeography of the region and tracing back the history of the flora of Western Ghats.

N. Awasthi and Rashmi Srivastava

Subproject I.D.3.2 : **Biodiagenetic investigation of Panandhro Lignite (Kutch) and dispersed organic matter in associated sediments**

Objective : *Characterization of lignites and quality assessment*

Fluorescence microscopic evaluation of liptinite macerals (hydrogen-rich microconstituents) from Panandhro lignite seams has revealed, in general, high incidence (higher than those evaluated under ordinary incident light). Resinite is the most dominant maceral followed by sporinite, cutinite, suberinite, fluorinite and exsudatinite. Alginite maceral represented by common occurrence of *Botryococcus* has been recorded for the first time in Indian Tertiary lignite.

The Panandhro lignite appears to be the richest in liptinite content than any other known lignite deposits of India.

B. K. Misra and G. K. B. Navale

Subproject I.D.3.3 : **Palynological study of the West Coast lignites**

Objective : *Morphotaxonomy of spore/pollen biostratigraphy and correlation with other southern basins*

Three palynological assemblages have been identified in the Aruthangal borehole (Alleppey District, Kerala) on the basis of qualitative and quantitative analyses. The assemblages contain dinocysts as well. Assemblage A is considered Eocene in age because of the presence of *Triangulorites, Sastripollenites, Striacolporites, Polybrevicolporites, Verrucolporites* and *Cheilanthoidospora.* Assemblage B is assigned Oligocene age as it contains *Crassoretitriletes, Polypodiaceaesporites* and *Margocolporites.* Palynotaxa associated with assemblage C (Lower Miocene) are *Striatriletes, Chenopodipollis, Quilonipollenites, Ctenolophonidites* and *Malyacearumpollis.* Palaeoclimate has been inferred as humid and tropical with plenty of rainfall. The environment of deposition was brackish water having mangrove swamps all along the coast line.

Systematic study of spore-pollen from the Payangadi of Cannanore District, Kerala has also been completed.

M. R. Rao

Subproject I.D.3.4 : **Studies of dispersed organic matter from the Karewa sediments**

Objective : *Characterisation of organic matter and study of depositional environment*

Selective photomicrography and quantitative assessment of various dispersed organic matter types of lignite/peat samples from Nichahom, Varnar, Botapathri, Budsungi, Ningal and Pakharpura sections have been carried out. Lithologs showing the nature of Karewa sediments exposed in these sections have been prepared. Charts and histograms showing the nature and distribution of dispersed organic matter in the Karewa sediments have also been prepared. The study suggests periodic flooding of Karewa lake resulting into sudden increase of land derived

organic matter.

Anand Prakash, Rakesh Saxena and O. S. Sarate

Subproject I.D.3.5 : **Biodiagenesis of lignites and associated sediments and Cuddalore Formation**

Objective : *Classification and correlation of lignite of associated sediments*

Palynological, organic matter typification and maturation studies on lignites from 3 bore holes—NLE 27, NLE 35 and NLE 36 samples from III New Mine area of Neyveli Lignite Field, Tamil Nadu have revealed that the lignite, mainly formed of terrestrial angiospermic vegetation, was deposited in a broad-coastal set up in warm-humid climatic conditions. The lignite has attained sub-bituminous C stage/rank. Floristically, the lignite more or less compares with the lignites of I and II mines. However, its quality deteriorates towards III mine, i.e., southern side of the deposit.

Scanning electron microscopic study of *Margocolporites, Trilatiporites, Cuddaloripollis, Droseridites, Jacobipollenites, Transdanubiaepollenites, Triangulorites, Neocouperipollis* and *Acanthotricolpites* has added additional morphological information.

G. K. B. Navale and Alpana Singh

Project I.D.4 : **Floristics, palynostratigraphy and biodiagenesis of sedimentary sequence of petroliferous Assam-Arakan Basin**

Objective : *Comparative morphology, biostratigraphy, palaeoecology and biodiagenesis*

Subproject I.D.4.1 : **Tertiary vegetational history of Assam Shelf**

Objective : *Morphotaxonomy of fossil woods and leaves, palaeoenvironment and evolution of flora*

Besides recording a number of already known species, a Malayan taxon *Koompassia*, new species of *Bauhinia* and a lauraceous wood have been identified from the Tipam Sandstone of Naginimara (Nagaland), Dimapur-Diphu Road and Bimalapur. Occurrence of *Koompassia* provides further evidence of the extension of Malayan elements into the Neogene tropical forests of the Indian subcontinent.

N. Awasthi and R. C. Mehrotra

Subproject I.D.4.2 : **Palynostratigraphy (spore-pollen) of the Upper Cretaceous-Palaeocene sequence in Assam Shelf**

Objective : *To establish palynostratigraphic zones in Upper Cretaceous-Palaeocene sequence in Assam Shelf*

Dandotiaspora and *Proxapertites* were studied under SEM. Morphological details characterising the two genera have been circumscribed.

K. Ambwani and R. K. Kar

Frequency diagrams of different coal seams of Tura Formation (Garo Hills) have been prepared to indicate the qualitative and quantitative behaviour of the palynotaxa. Charts have also been prepared to deduce the palaeoecology of the area at the time of deposition. This assemblage was also correlated with the Langrin Coalfield and in both *Dandotiaspora dilata* Cenozone was recognised.

K. Ambwani and R. S. Singh

Palynological studies of about one hundred samples from five coal seams exposed in different parts of Langrin area show that the coals of Tura Formation were deposited near shore-line and the marine influence in the upper two seams was comparatively more. The assemblages of pollen and spores are more or less homotaxial with that of Shella Formation.

R. S. Singh

Palynological assemblage of Lynkerden Colliery, Meghalaya consists of 20 genera and 37 species. Important Palaeocene markers are: *Dandotiaspora dilata, D. telonata, D. auriculata, Matanomadhiasulcites maximus, Lakiapollis ovatus, Retitribrevicolporites matanomadhensis, Kielmeyrapollenites syncolporatus* and *Meliapollis ramanujamii.* A summary diagram was prepared to depict the palaeoecological conditions of deposition.

J. Mandal

Palynostratigraphical investigation of Ledo Colliery, Tikak Prabat Formation (Upper Oligocene), Assam was completed. This work was submitted in the form of a Ph.D. thesis entitled "Palynostratigraphy of Tertiary sediments in north east India"

Palynology of road section exposed near Maibong Railway Station belonging to Surma Series of Tertiary was completed. The assemblage comprises 39 genera and 58 species including some Mesozoic and Palaeozoic reworked pollen.

B. D. Mandaokar

Palynological assemblage of Prang Limestone (Middle Eocene) exposed at Jowai-Badarpur road consists of 35 genera and 43 species, comprising pteridophytic spores and angiospermic pollen. The most important find is the presence of *Striatriletes* (Parkeriaceae) in good percentage in the assemblage. This is incidentally the oldest record of Parkeriaceae in the world.

R. K. Kar

Subproject I.D.4.4 : **Biodiagenesis of Tertiary coals in Assam**

Objective : *Organic matter classification and maturation level*

Kerogen typing and assessment of Thermal Alteration Index (TAI) of 160 samples of Dharmara II bore-hole in Arunachal Pradesh revealed that the sequence from Eocene to Mio-Pliocene is dominated by amorphous Kerogen including finely divided organic matter. However, woody and degraded Kerogen types show increase wherever carbonaceous or coaly bands are present.

Fluorescence microscopic study of 15 coal samples from 5 lateral sections of the

main seam of Nangwalbibra Colliery, Garo Hills, Meghalaya revealed quite high proportion of liptinite macerals (hydrogen-rich micro-constituents); resinite has been found to be most dominant maceral. Common occurrence of maceral alginite (*Botryococcus*) in these coals is the first alginite record from any Indian Tertiary coals. Such a high proportion of liptinite macerals rendered these coals highly suitable for hydrogenation.

B. K. Misra

Project I.D.5 : **Fossil flora, palaeogeography, palaeoecology and palynostratigraphy of Cauvery, Palar, Krishna-Godavari, Bengal and Andaman basins**

Objective : *Morphotaxonomy, biozonation, correlation, biostratigraphy, palaeoecology and phytogeography*

Subproject I.D.5.2 : **Palynostratigraphy of the Gondwana sediments of Palar Basin**

Objective : *Palynological zonation and age determination*

Important taxa *Classopollis, Podocarpidites, Contignisporites, Callisporă, Boseisporites, Aequitriradites* and *Monolites* are recorded from the Sriperumbudur Formation.

Suresh C. Srivastava

Subproject I.D.5.3 : **Phytoplankton biostratigraphy of Cretaceous-Tertiary sequence of Cauvery and Palar basins**

Objective : *Identification of phytoplankton taxa, biozonation, age determination and palaeoenvironment of sedimentary sequences*

Morphotaxonomy of dinocyst taxa recovered from the surface and subsurface sedimentary sequences of Cauvery and Palar basins, respectively, has been concluded. Based on dinocyst distribution in time and space, Barremian age has been assigned to subsurface sequence of Palar Basin, whereas Early Albian, Turonian-Coniacian and Maestrichtian ages are assigned for Dalmiapuram, Trichinopoly and uppermost Ariyalur formations, respectively.

Early Cretaceous dinocyst assemblages published from subsurface of Krishna-Godavari and Cauvery basins have been reassessed and revised suggesting Hauterivian-Barremian age.

K. P. Jain and Khowaja-Ateequzzaman

Subproject I.D.5.4 : **Tertiary megafossils of Cauvery Basin and their comparison with extant plants**

Objective : *Comparative morphology of petrified and carbonised woods and leaves and palaeoecology*

Out of a large number of carbonised woods studied from the Neyveli lignite

deposits, a few have been identified with the woods of Hamammelidaceae, Lecythidaceae (*Barringtonia*) and Leguminosae. The report on a carbonised wood of *Bouea* has been finalised.

Anil Agrawal

Subproject I.D.5.6 : **Fossil calcareous algae from Cauvery Basin**

Objective : *Morphotaxonomy of calcareous algae and their significance as rock builders*

Examined about forty thin sections of Kallakudi Limestone. Identification and photodocumentation of fossil algae belonging to Dasycladaceae, Solenoporaceae have been partly completed.

A. Rajanikanth

Subproject I.D.5.7 : **Floristics of Neogene sediments in Bihar and Bengal**

Objective : *Vegetational history of the Neogene period*

Draft manuscript dealing with leaf, flower and fruit impressions and petrified woods from the Cenozoic localities of Bihar and West Bengal was compiled. The assemblage consists of about 31 genera belonging to 22 families of dicotyledons. The study is the first of its kind on the Cenozoic beds of Palamau District Bihar. Family Asclepiadaceae and the genera *Spondias, Erythrina, Combretum, Mytragyna, Alstonia* and *Cryptolepis* have been described for the first time from the Cenozoic of India as megafossils.

From West Bengal fossil wood of *Kayea* (Guttiferae) and family Lauraceae have been reported for the first time.

M. B. Bande and G. P. Srivastava

Subproject I.D.5.8 : **Cenozoic diatom biostratigraphy, palaeogeography and palaeoecology of the Cenozoic diatoms**

Objective : *Morphotaxonomy, biostratigraphy, palaeogeography and palaeoecology of the Cenozoic diatoms*

Typical Miocene taxa have been observed in rich assemblage of well-preserved diatoms and silicoflagellates recovered from eight samples of the havelock Island.

Rich diatom and silicoflagellate horizons have been identified in the deep wells of the Andaman Basin (ONGC collection). The assemblage is represented by both centric and pennate diatoms of Miocene age.

Anil Chandra

Project I.D.6 : **Palynostratigraphy and fossil floras of sedimentary basins in Gujarat, Rajasthan and Narmada Valley**

Objective : *Morphology, palynostratigraphy, biozonation and palaeoenvironments*

Subproject I.D.6.1 : **Studies of Tertiary plants from Jaisalmer and Cambay basins**

Objective : *To build up vegetational history*

Fossil woods of *Anisoptera, Entandrophragma, Albizia* and *Anogeissus* have been identified from the Neogene sediments near Jaisalmer. Occurrence of *Entandrophragma* further confirms the presence of African elements in the Indian Neogene.

From the Neogene sediments of south Gujarat, woods resembling *Calophyllum, Kingiodendron, Lagerstroemia, Shorea* and *Sonneratia* have been recorded. Investigation of two carbonised woods, viz., *Sonneratia* and *Terminalia* from the Rajpardi lignite mine has been completed.

J. S. Guleria

Subproject I.D.6.3 : **Nannoplankton morphology and biostratigraphy of Mesozoic and Tertiary sediments of Kutch and Jaisalmer basins**

Objective : *To study various lithounits for nannoplankton biostratigraphy and for deducing palaeoenvironment*

Based on high resolution litholog incorporating background data of megafossils, trace fossils and sedimentology, 5 palaeoceanographic events are recognised in terminal part of Jaisalmer Formation (Kuldhar member), which has yielded moderately well-preserved nannoflora permitting correlations in Tethyan realm. Nannofossil taxa, viz., *Stephanolithion, Biscutum, Ellipsagelosphaera, Cyclagelosphaera, Lotharingius, Ansulasohaera, Ethmorhabdus, Calyculus* and *Zygolithites* are recognised under SEM.

Sparse, Though datable mannoflora of Aptian-Albian age has been recorded in a bore well sample (300 m) from Habur Village of Jaisalmer Basin.

Rich assemblage of calcareous nannoplankton including calcareous dinocysts from Harudi and Fulra Limestone formations is assigned to NP17 (*Discoaster saipanensis* zone of (Martini emend.). Sixteen new species are described.

Predominance of braarudosphaerids, rhahdosphaerids and holococcoliths suggests extremely shallow near-shore deposition in a marine coastal shelf.

S. A. Jafar and Jyotsana Rai

Subproject I.D.6.4 : **Palynology of Mesozoic deposits in Narmada and Saurashtra basins**

Objective : *Palynostratigraphy, biozonation and correlation*

Palynological study of tenuitate and atenuitate nonsaccate pollen from Triassic-Jurassic-Cretaceous sediments from India shows 80% atenuitate pollen in Lower Cretaceous sediments.

Sediments from Pipli bore-hole, Surendranagar District, Kathiawar consist of *Callispora potoniei, Trilites fusus, Staplinisporis caminus, Coptospora kutchensis, Impardecispora, Lametatriletes mesozoicus* and *Schizosporis parvus*. The assemblage suggests Lower Cretaceous age.

Pramod Kumar

Subproject I.D.6.5 : **Floristics, phytogeography and biostratigraphy of Lameta Group**

Objective : *Morphotaxonomy, floristics, phytogeography and biostratigraphy*

Fertile organs of *Azolla* and some fragmentary plant remains have been recovered from Dongargaon. The presence of this aquatic fern in the Lameta sediments is suggestive of lacustrine sedimentation.

Sukh-Dev

Project I.D.7 : **Palynostratigraphy and organic petrology of the Tertiary sediments of Simla Hills and adjoining areas**

Objective : *Biozonation, age determination and palaeoecological interpretation*

Subproject I.D.7.1 : **Palynostratigraphy of the Lower Tertiary sediments of Simla Hills and adjoining areas**

Objective : *Biozonation, age determination and palaeoecological interpretation*

Palynoflora from Kakara sediments (Eocene) from the Kakara-Chapla group of villages (Himachal Pradesh) consists of 27 genera and 43 species. Dinoflagellate cysts are the major constituents of this assemblage. Significant forms are *Achilleodinium, Cordosphaeridium, Hystrichosphaeridium* and *Cyclonephelium*. The Kakara assemblage is distinct in composition and is not comparable to any of the established palynozones in the Simla Hills. The palynofossils are suggestive of Lower Eocene age; Palaeocene dating on the basis of palaeontological data is not confirmed. Occurrence of *Thalassiphora* and several other taxa indicates that the sediments were deposited in a near-shore environment.

Chemical processing of Subathu samples from the Arki and its adjoining areas has been completed. Morphotaxonomic study of the Garkhal palynofossils including critical observations of *Hystrichokolpoma* and *Diphyes* has partly been carried out. Recovery of dinocysts from the red bed facies, hitherto, included in the Dagshai Formation near Garkhal suggests that this part of the sequence, in fact, may be representative of the Subathu Formation.

Hari P. Singh and Samir Sarkar

A comparative account of several new palynotaxa recovered from Subathu-Dagshai formations in Jamatah-Dadahu area, Sirmur District, Himachal Pradesh has been prepared.

Asha Gupta

Subproject I.D.7.2 : **Palynostratigraphy of Tertiary sediments of Arunachal Pradesh**

Objective : *Morphotaxonomy, biozonation, correlation and palaeoecology*

Tertiary palynoflora from Subansiri, Kameng and East Siang districts (Arunachal Pradesh) has been investigated. Lower Tertiary sediments are identified by the presence of *Tricolporopollis, Coramendalipollis, Lakiapollis* and *Ctenolophonidites.* Palynofloral resemblance between the Tertiary of Arunachal Himalaya and Assam-Arakan Basin has been noticed indicating thereby the possible continuation of the Tertiary sequence of Brahmputra Valley up to the foot-hills of Arunachal Pradesh.

S. K. M. Tripathi

Project I.D.8 : **Palaeobotany and palynology of Tethyan Himalaya**

Objective : *Morphotaxonomy, biostratigraphy and age determination*

Subproject I.D.8.1 : **Palaeophytic and vegetational history of the Peritethyan realm**

Objective : *Morphotaxonomy, floristics, biostratigraphy and age determination*

Composition of fossil floras that grew around the northern margin of the eastern Gondwana during the Upper Palaeozoic/Mesozoic times has been evaluated to understand the distribution of plant fossils and its bearing on the concept of a 'greater' India. A serious attempt in this direction has been lacking probably due to the fact that no proper diagnosis of the typical Gondwana Flora is available. The presence of *Glossopteris*-type leaves does not automatically depict a Gondwanan affinity to a flora unless supported by the presence of typical fertiligers or at least by the *Vertebraria* axes. The floras that have been so evaluated originate in the Permian of new guinea, Indonesia, Thailand, Malaysia, Tibet, Northern China, India (Kashmir), Saudi Arabia, Iran, Iraq and Turkey and Mesozoic of India (Ladakh), Bhutan and Nepal. The analysis shows that though some of the floral assemblages contain certain elements that could be of Gondwanan affinity yet the overall composition of almost all the floral assemblages except that of the one from Kashmir, is basically Cathaysian. It is therefore concluded that the Indian Gondwana did not extend north of the Indus-Yarlung-Zangbo Suture zone.

Hari K. Maheshwari and Usha Bajpai

Subproject I.D.8.2 : **Palynostratigraphic studies of Palaeozoic and Mesozoic sediments in Western Himalaya**

Objective : *Morphotaxonomy, correlation and dating of sediments*

To understand the relationship of the Tethyan palynoflora, detailed comparison of assemblages from the circum-Tethys region has been made. It has been concluded that distinct provinciality existed during Carboniferous, Permian and

Triassic times. The Himalayan belt has some relationship with Cathaysia, Middle East and the Mediterranean region but the main thrust of influence is from Indian Peninsula.

R. S. Tiwari and Vijaya

Subproject I.D.9 **Reconstruction of Quaternary vegetation and climatic pattern**

Objective : *Palynostratigraphy, palaeoenvironment and palaeoclimate*

Subproject I.D.9.1 : **History of vegetation and climate in the subtropical, temperate and alpine belts of Himachal Pradesh and Uttar Pradesh**

Objective : *Palaeofloristics and palaeoenvironments of Quaternary period through palynological studies*

Prepared a comparative chart from Rewalsar profiles in Himachal Pradesh and it was found that the vegetation pattern is uniform throughout the profile. However, around 600 yrs B.P. a changeover from arboreals to non-arboreals has been recorded which may perhaps be due to tillage.

Pollen analysis of one meter deep bottom profiles, one each from Ram Tal, between Ram Tal and Sita Tal and Naukuchia Tal revealed dominance of Chirpine-oak forest over the non-arboreals.

Pollen analysis of 24 surface samples from Tarag Tal, Khurpa Tal and Shatrughan Tal shows the dominance of chirpine woods. However, at places oak-woods dominate over chirpine woods. The entire sequence almost compares with the modern vegetation except for a few broad-leaf forms such as *Celtis, Ulmus, Salix, Populus,* etc.

Pollen morphology of 25 modern plant taxa from Kumaon Himalaya was completed and LM and SEM study of three species each of *Xanthium* and *Quercus* was carried out.

Chhaya Sharma and M. S. Chauhan

Subproject I.D.9.2 : **History of vegetation and climates in tropical montane forest in Kerala**

Objective : *Palynological investigation to build up a complete floral succession in forests of Anamalai Hills and Silent Valley*

Pollen analysis of three soil profiles one each from Schichalli, Arumparai and Karian Shola in Anamalai Hills has been completed. The study has revealed that the samples are not very rich palynologically. Nevertheless, pollen of herbal elements such as Poaceae, Asteraceae, etc. has been recorded. In view of the insufficient occurrence of pollen and spores, for percentage calculation it is proposed to undertake heavy-liquid analysis and then build up the floral succession in Anamalai Hills.

Pollen morphology of twenty arborescent taxa of shola forest has been critically investigated and photomicrography completed.

H. P. Gupta and S. K. Bera

Subproject I.D.9.3 : **Dendrochronology of Indian tropical trees**

Objective : *Tree ring analysis and decoding climatic data with emphasis on monsoon records*

Processed 77 samples collected from U.P., Karnataka and Andhra Pradesh. Cross dating of 15 cores of *Cedrus deodara* from Uttar Pradesh Himalaya has been completed. Cross dating of 15 cores of *Michelia* spp. has not shown climatic signal.

R. R. Yadav and A. Bhattacharyya

Project I.D.10 : **History of mangrove vegetation in India**

Objective : *Reconstruction of Holocene vegetation and to understand the ecosystem, causes of deterioration of mangroves in time and space and its impact on environment*

Pollen analysis of Chilka profile-I has been completed and two computerised pollen diagrams prepared. Occurrence of characteristic mangrove taxa and also the taxa from hinterland vegetation has been observed. The study indicates the occurrence of mangrove forest in and around the lake about 2,000 years B.P.

D.O.M. study of Chilka profile-I depicts the preponderance of structured terrigenic palynodebris followed by semiamorphous organic matter. Various microbial degradational stages have been documented.

The occurrence of core-mangroves such as *Rhizophora, Heritiera, Ceriops, Avicennia* and *Excoecaria* in four bottom samples from Chilka Profile-II supports the existence of mangrove forest.

H. P. Gupta and Asha Khandelwal

Project I.D.11 : **Geochronology of Indian rocks**

Subproject I.D.11.1 : **Radiocarbon dating of carbonaceous material from Quaternary deposits and of cultural importance**

Objective : *To investigate rate of subsidence of Ganga plain, rate of sedimentation in Indian Ocean and chronology of vegetational changes in the Himalayan region*

Sixty five samples including anthracite background and NBS oxalic acid (contemporary radiocarbon standard) were processed. C-14 ages for 54 samples have been calculated.

Sediment core raised at 10 N 72 E in Arabian Sea (Core SK/20/185) and at 4 S 49 E at Somali Basin (Core SK/16/1) have been dated. The materials of the cores are calcareous/siliceous oozes. Core SK/20/185 shows a disturbed history with surface

samples dating to 21,000 yrs B.P.

Kankar deposits from various localities in Haryana were dated. C-14 ages range from 3,200 yrs B.P. to 7,100 yrs B.P. showing the aridity phases at different places. A profile of alluvium containing Kankar horizons from Faizabad (Central Ground Water Board drilling) was dated to infer the past aridity phases and their relationship to the drainage pattern of major rivers in U.P. Unlike the profiles in the southern part of Ganga River (Kanpur and Fatehpur) the Kankar horizons in northern part (Faizabad) are deep down at depths greater than 70 m which are dated to 19,000 yrs B.P. This age coincides with low stand of sea level at the glacial maximum.

Chilka Lake, Orissa profile at a depth 2.65 m dates to 1620 yrs B.P. A sedimentation rate of 10 cm/100 yrs is derived for this deposit at this depth.

Archaeological sites at Hulaskhera in Lucknow, Vagod and Dwarka port in Gujarat and Senuwar in Rohtas were also dated.

The glass system for acetylene synthesis has been fabricated and tested. A number of trial runs of acetylene synthesis have been carried out and the parameters of temperature pumping speed, etc. have been standardized for optimum recovery.

G. Rajagopalan

Fission tracks revealed on the surface of apatite grains of Gabbro rock sample, Ganga Valley (F-T age 1320 ± 65 Ma).

Subproject I.D.11.2 : **Fission Track dating of the rock samples**

Objective : *To date minerals and rocks by Fission Track method*

Three petrified wood specimens from the Deccan Intertrappean beds have been processed for F-T dating. After grinding, polishing and etching, fossil track density (Ps) = 1.95×10^3 t/cm^2 has been obtained for Deorikhurd specimen. After re-etching induced track density (Pi) = 1.885×10^3 t.cm^2 has been obtained. The F-T age for this has been calculated as 48 ± 4 Ma.

The track length measurement study has been carried out for International standard sample G1-O(g) and Vindhyan sample S-7. The average length was found to be in the range of 3-5 μm for both fossil and induced glauconitic grains. It indicates that the samples have not been subjected to any severe annealing event in geologic past. In S-7 sample S and S values come out to be as 3.04% and 2.944%. The close agreement of these values indicates uranium homogeniety in sample S-7.

The track length measurement study has also been carried out for apatite grains separated from Gabbro rock sample (BSFT173/cc-18).

G. Rajagopalan and A. P. Srivastava

Subproject I.D.11.3 : **Setting up of Potassium-Argon Dating Laboratory**

Objective : *To establish the K-Ar dating facility*

Extraction and purification system for Argon was completed. The vacuum achieved is in the range of 10 torr and keeps at 10 torr in static mode over a few days. By using miniature components, the system volume has been considerably reduced. Ion pump has been used alongwith diffusion and rotary pumps and Saes getters have been included. A contrast unit has been made permitting simultaneous gettering of hydrocarbons and hydrogen.

G. Rajagopalan and C. M. Nautiyal

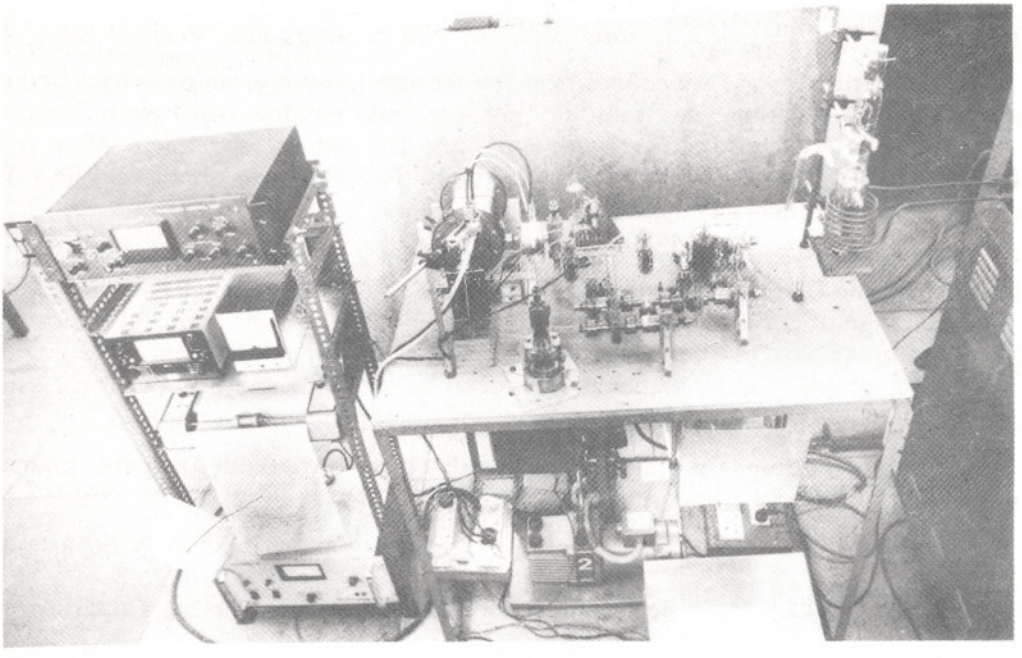
Project I.D.12 : **Environmental and depositional studies in modern sediments**

Subproject I.D.12.1 : **Study of Kerala mud banks and estuaries to develop a suitable analogue to understand ancient sediments**

Objective : *To understand the depositional environment of mudbank and to develop a profile of palynological studies in marginal areas*

Palynological study of eighty samples collected from Vembanad Lake, Alleppy and Quilandy mudbank shows that spore, pollen grains and other terrestrial vegetal matter are dominant near the coast while the microforaminifers are in high frequency in the off-shore region. Palynological assemblages of Vembanad lake and mud banks are more or less the same indicating derivation of the material from similar source.

R. K. Kar and Madhav Kumar in collaboration with CESS



An Ultra High Vacuum System assembled for extraction and purification of Argon from rock samples.

Subproject I.D.12.2 : **Diatom biostratigraphy of the core samples from D.S.D.P. site 218**

Objective : *Morphotaxonomy, palaeogeography and palaeoecology of the Cenozoic diatoms*

In the core sample (Quaternary to Pliocene, 186 m) of DSDP, the site 218 centric diatoms dominate over the pennate forms. Some of the important taxa recovered are *Coscinodiscus, Hemidiscus, Thalassiosira, Actinocyclus, Asteromphalus, Asterolampra, Cyclotella, Milosira, Podocystis, Amphora, Nitzchia* and *Diploneis*. A few silicoflagellates have also been observed.

Anil Chandra

Project I.D.13 : **Atlases of stratigraphically and ecologically significant Indian fossil taxa and fossil floras**

Subproject I.D.13.1 : **Catalogue of stratigraphically significant palynofossils in the Indian Gondwana sediments**

Objective : *Cataloguing of stratigraphically significant palynofossils*

Circumscription of resolved species of four pollen genera, viz., *Callumispora, Parasaccites, Crucisaccites* and *Faunipollenites* has been completed.

R. S. Tiwari, Suresh C. Srivastava, Archana Tripathi and Vijaya

Subproject I.D.13.2 : **Software development for morphotaxonomy and palynostratigraphy**

Objective : *To update data bank on palynology of Gondwana related sediments and to develop software for morphography of taxa and palynostratigraphy*

New literature on palynology and other related aspects have been consulted and reference cards prepared to update the data bank.

R. S. Tiwari, Suresh C. Srivastava, Archana Tripathi, Vijaya, B. N. Jana, Neerja Jha, Ram Awatar, K. L. Meena and A. P. Bhattacharyya

Subproject I.D.13.3 : **An atlas of Tertiary palynofossils**

Objective : *To catalogue stratigraphically significant palynofossils*

(a) Pollen

Pollen genera *Lakiapollis, Retitribrevicolporites, Tricolporopilites, Tricolporocolumellites, Tripilaorites, Triangulorites, Matanomadhiasulcites, Tricolpites, Neocouperipollis, Palmidites, Cryptoporites* and *Sastriipollenites* were studied. Morphological circumscriptions of these taxa have been made. Their stratigraphic ranges have been documented. Comparative studies have enabled to relate them to extant taxa.

B. S. Venkatachala, C. Caratini, C. Tissot and R. K. Kar

(b) Spore

Palynotaxa *Biretisporites, Dictyophyllidites, Deltoidospora, Gleicheniidites, Intrapunctisporis, Osmundacidites, Khariasporites, Lakiasporites, Foveosporites, Foveotriletes, Cingulatisporites, Corrugatisporites, Seniasporites, Biswasispora* and *Schizaeoisporites* were studied in order to understand their stratigraphical and ecological significance. Stratigraphic ranges of several taxa were represented graphically. Botanical affinity of several taxa was inferred. A key of Indian Tertiary spores is under preparation.

Asha Gupta

Subproject I.D.13.4 : **An atlas of Jurassic-Cretaceous plants of India**

Objective : *To prepare a catalogue of Indian Jurassic Cretaceous plants*

Morphotaxonomic studies on some pteridophytes belonging to Equisetaceae, Gleicheniaceae, Dipteridaceae and genera *Cladophlebis* and *Sphenopteris* have been carried out.

Sukh-Dev

Project I.D.14 : **Deccan Intertrappean Flora**

Objective : *Critical investigation of the flora to trace the phylogeny and evolution of angiosperms, phytogeography and ecology of Tertiary Deccan flora*

The Deccan Traps represent only a part of the long history of volcanism on the Indian subcontinent covering about 5 × 10 km area in western and central India. Palaeoenvironmental, palaeogeographical and stratigraphical implications of important plant fossils from (a) Rajahmundry assemblage, (b) Nagpur-Chhindwara assemblage, (c) Bombay-Malabar-Worli Hills assemblage, and (d) Mandla assemblage have been discussed.

The evidence of plant fossil has been synthesized to interpret the age of the Deccan Traps in the background of palaeontological, palaeomagnetic and radiometric data.

M. B. Bande, Anil Chandra, B. S. Venkatachala and R. C. Mehrotra

The Deccan Intertrappean flora is the most important Early Tertiary flora of India. It represents the stage from which the vegetation of India started acquiring its present composition. The available information on the intertrappean plant fossils from Nagpur-Chhindwara and Mandla assemblages has been critically analysed to reconstruct the palaeoclimate and palaeogeography of central India during Early Tertiary. The evidence of plant fossils indicates a warm tropical climate with heavy rainfall and uniform temperature throughout the year in this region. It is attributed to an almost equatorial position of peninsular India and a near vicinity of sea in central India during this period.

The flora has also been analysed to understand the migration of various plant taxa from India to Southeast Asia and vice-versa after the joining of the Indian Plate to the Asian Plate.

M. B. Bande

Project I.D.15 : **Siwalik flora and its stratigraphical implications**

Objective : *Floral composition of the Siwalik Group, palaeoecology and phytogeography of the Himalayan foot-hills during the period*

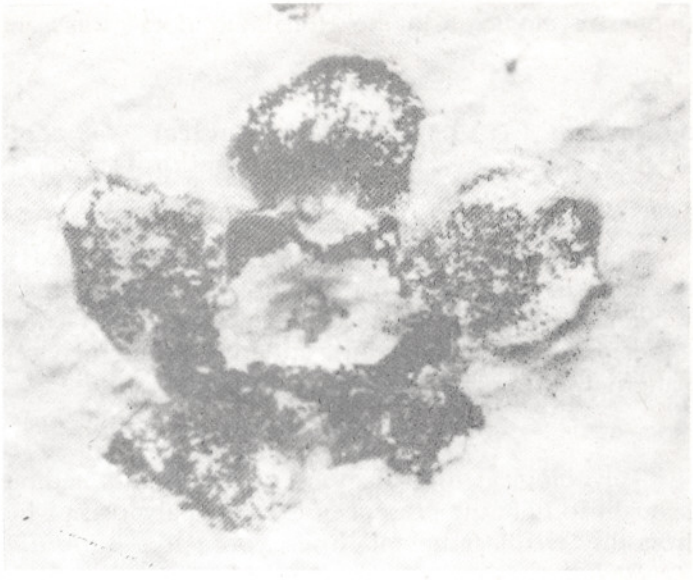
Subproject I.D.15.1 : **Siwalik plant megafossils**

Objective : *Comparative morphology, floristics, palaeoecology and phytogeography*

A leaf-impression from the Lower Siwalik sediments of Bhikhnathoree near India-Nepal border in West Champaran District, Bhiar has been identified with that of a Malayan taxon *Anisoptera curtesii*.

N. Awasthi

Morphotaxonomic study of leaf taxa from Mahendra Raj Marg Section, Suraikhola, Nepal has been completed. Leaf-impressions collected from Arjunkhola—Ghorai Road Section, Nepal were studied in detail. Some leaves have



A fossil angiospermous flower (×6) from Siwalik sediments, Nepal.

been identified with those of extant species representing 18 families of the dicotyledons. Fossil woods collected from the same section have been identified as *Dipterocarpus* and *Chrysophyllum*. The leaf assemblages from Suraikhola and Arjunkhola sequences include a number of Malayan and Burmese elements suggesting a close phytogeographical link between the Indian subcontinent and southeast Asia during Neogene.

A small collection of leaf-impressions from Lower Siwalik sediments exposed on the bank of Nainital Nala, Ranibagh near Kathgodam has been examined. The leaves have been identified as *Zizyphus, Cassia, Samanea, Dialium* and *Cynometra*.

The genus *Duabanga* has been found in the Lower Siwalik sediments of Kalagarh, U.P. Presently it occurs in north-eastern India extending up to the foot-hills of north Bengal. Its extinction along with several other taxa from the Himalayan foot-hills of Uttar Pradesh reflects considerable change in the environmental conditions since the Neogene.

N. Awasthi and Mahesh Prasad

Twenty leaf-impressions belonging to dicotyledonous families from the Siwalik sediments near Oodlabari, Jalpaiguri District have been identified. Some of them resemble the Malayan taxa.

N. Awasthi and J. S. Antal

Subproject I.D.15.2 : **Studies on plant fossils from Siwalik sediments around Jawalamukhi-Ranital, Himachal Pradesh**

Objective : *Morphotaxonomy and palaeoecology*

A research paper entitled "Fossil leaves of *Dipterocarpus* from the Lower Siwalik beds near Jawalamukhi, Himachal Pradesh was published. Two new species of *Fissistigma* and *Terminalia* were recorded. Another paper entitled "Advent of

temperate elements in the Himalayan flora" was sent for publication.

R. N. Lakhanpal

Subproject I.D.15.3 : **Palynological study of the Siwalik sediments from Suraikhola area, Nepal**

Objective : *Systematic palynology, biozonation and palaeoecology*

The Arjunkhola assemblage is rich in several fresh water swampy elements as is the case in the Suraikhola assemblage. Various stratigraphic levels contain high incidence of pollen grains of cycad affinity, not known from the Siwaliks so far. Other palaeoassociations of taxa depict an interplay of semi-evergreen vegetational pattern during Siwalik times in the area.

Samir Sarkar

Palynological investigations of the Siwalik sediments (Bagh Rao, U.P.) have brought to light the presence of several palynotaxa which were not reported earlier from the Siwalik sediments. These forms are—*Milfordia, Aglaoreidia*, megaspores of *Azolla* and member of Zygnemataceae. The palynoflora suggests an Upper Miocene age and fresh water swampy conditions of deposition for these sediments.

Samir Sarkar, A. P. Bhattacharyya and H. P. Singh

Project I.D.16 : **Plant remains from pre- and protohistoric sites in India**

Objective : *Plant economy of ancient India*

Subproject I.D.16.1 : **History of economic crops and other plants from pre- and protohistoric sites**

Objective : *To trace history of crops and other plants*

Remains of carbonised seeds and fruits from the ancient deposits of Late Harappan culture at Hulas in Saharanpur District, U.P., suggest that the settlers at this site practised an advanced agriculture from *ca* 2,000 to 12,00 B.C. The remains comprise rice (*Oryza sativa*), barley (*Hordeum vulgare*), three forms of wheat, viz., dwarf-wheat (*Triticum sphaerococcum*), bread-wheat (*T. aestivum*) and club-wheat (*T. compactum*), jowar-millet (*Sorghum bicolor*), finger-millet (*Eleusine coracana*), oat (*Avena sativa*), lentil (*Lens culinaris*), chick-pea (*Cicer arietinum*), horse-gram (*Dolichos biflorus*), field-pea (*Pisum arvense*), grass-pea (*Lathyrus sativus*), green gram (*Vigna radiata*), cow pea (*Vigna unguiculata*), cotton (*Gossypium arboreum/herbaceum*) and castor (*Ricinus communis*). Cultivation of rice has also been deciphered in the impressions of paddy husk embedded in the burnt mud-clods and the remains of husk peels from the floor pieces.

Seeds of *Cenchrus ciliaris* and *Coccinia grandis* and hypanthodium of *Ficus* sp. cf. *F. religiosa* belong to wild plant remains. Remains of fruit and shells belonging to walnut (*Juglans regia*) and almond (*Prunus amygdalus*), both of European origin suggest that dry fruits were also used in the subsistence economy of Harappans.

K. S. Saraswat

Subproject I.D.16.2 : **History of early domestication of plants**

Objective : *To work out usefulness of wild plants in ancient times and the origin of cultivars*

Crop remains from the different cultural horizons at Hulaskhera (*ca* 700 B.C.—500 A.D.) in Lucknow District include barley, bread-wheat, dwarf-wheat, rice jowar-millet, finger-millet, oat (*Avena* sp.), field-pea, grasspea and green-gram. In addition, Ber, fruit of (*Zizyphus* sp.) and Bahera (*Terminalia belerica*), Semal (*Bombax* sp.) seeds have also been found. Occurrence of Bahera shows that the fruit might have been used as medicine in the Vedic period.

Wood charcoal pieces from ancient Kausambi (*ca* 600 B.C.) in Allahabad District, U.P. have been identified as belonging to *Zizyphus* sp., *Terminalia* sp., *Lagerstroemia* sp., *Anogeissus* sp., *Dalbergia* sp., *Commiphora* sp., *Soymida febrifuga, Holarrhena antidysenterica, Adina cordifolia* and Bamboo.

Chanchala

Project Sp. 1 : **Geology, palaeobiology, geochemistry and isotopic composition of Archaean sediments of India (DST no. 22(IP-6)/84-STP II)**

Objective : *To search stromatolitic structures and organic remains in the Archaean sediments and their evaluation*

Stromatolites earlier reported from Vanivilas Formation of Chitradurga Schist Belt have been studied in detail. The stromatolites of the Chitradurga Belt and Dodguni area resemble columnar stromatolite forms, viz., *Gymnosolen, Tungussia, Kussiella*, etc. They also show development of wall structure which is an advanced feature, not known in Archaean stromatolites.

Stromatolites have been found in the Shimoga Schist Belt, Dharwar Supergroup. Stratifera type stromatolites showing development of pseudocolumnar structures and occasional development of domes occur in the cherts as well as dolomites near a Manganese mine. This occurrence further confirms widespread biogenic activity prior to 2.6 Ga in the Dharwar Craton.

Microfossils from Proterozoic localities were also examined. The Nauhatta Limestone Formation (Lower Vindhyan) at Rohtasgarh has yielded well-preserved mammilated mats of coccoid cyanobacteria. Filamentous forms are rare. The assemblage includes *Eomycetopsis robusta, Eoentophysalis belcherinsis, Myxococcoides, Glenobotrydion aenigmatis, Sphaerophycus parvum*, etc. This study has helped in understanding the preservational as well as degradational aspects of the microbiota.

Experimental studies were also conducted to understand and distinguish extant contaminants from authentic Precambrian microfossils. Extant algae and fungi were treated with hydrochloric and hydrofluoric acids. The material on study shows that all fungal and some of algal material can withstand this treatment and show forms morphologically comparable to many Precambrian microfossils. The study has

important bearing on Precambrian microfossil study through maceration method.

B. S. Venkatachala, Manoj Shukla, V. K. Yadav, Mukund Sharma and Rajendra Bansal (jointly with NGRI Hyderabad and BARC, Bombay)

Project Sp. 2 : **Nannoplankton biostratigraphy and palaeoenvironmental framework of Cretaceous-Palaeocene sedimentaries of Andaman Islands, India**

Objective : *To study various lithounits for nannoplankton productivity and to deduce age and palaeoenvironment*

Preliminary field work in Baratang and middle Andaman Islands revealed tectonic complexity and poor exposures. Dominantly flysch sequence revealed rare limestone/marly layers. Mud volcano samples show the presence of important nannofloral elements of Late Cretaceous to Palaeogene age, which are being documented in detail under the light microscope.

S. A. Jafar, U. C. Mainali and O. P. Singh

Project Sp. 3 : **Palynostratigraphy of the Ratnagiri and Neyveli lignites and associated sediments (CSIR no. 24(171)/86-EMR II)**

Objective : *Morphotaxonomy of spore/pollen, biostratigraphic zonation, dating and correlation of sediments with other lignite bearing sediments of south India and palaeoecological interpretations*

Palynological assemblages from the Ratnagiri beds and VRM and VDM shallow wells contain fungal remains, pteridophytic spores and angiospermic pollen. They indicate prevalence of tropical-humid climate and deltaic near shore environment of deposition. Two new exposures of Ratnagiri lignites have been discovered in Sindhu Durg District, Maharashtra. These beds contain both micro- and mega-plant fossils.

Palynological assemblages of subsurface lignites of South Arcot District, Tamil Nadu exhibit the presence of characteristic Lower Tertiary palynotaxa, viz., *Proxapertites, Neocouperipollis, Lakiapollis,* etc.

R. K. Saxena, N. K. Misra and Sanjay Khare

Project Sp. 4 : **Palynological dating and correlation of newly identified coal-bearing strata in Birbhum, Diwanganj Area, West Bengal**

Objective : *To build palynostratigraphy through coal-bearing subsurface strata in these areas, and to determine their age*

Chemical processing of samples from bore-hole no. RKJ-1A and DNJ-11 has been done. A rich and diversified palynoflora has been recovered. Photomicrography, identification and morphographic studies have been partly carried out.

R. S. Tiwari and D. Chowdhury

Project Sp. 5 : **Phytoplankton biostratigraphy with emphasis on an integrated model for dating, biozonation and correlation of marine Cretaceous-Tertiary sequence of Assam Shelf (CSIR no. 24(170)/86-EMR-II)**

Objective : *Dinocysts morphology, taxonomy and identification of index phytoplankton taxa; biozonation, age determination and correlation of sedimentary sequences; precise demarcation of time boundaries and palaeoenvironmental and palaeobiogeographic interpretations*

A continuous succession of rich dinocyst assemblages is discovered from upper part of Mahadek formation and entire Langpar Formation. Occurrence of diagnostic Maastrichtian dinocysts, e.g., *Dinogymnium* and *Palynodinium* species, and typical Danian taxa, viz., *Hafniaspbaera* and *Danea* species, besides *Cyclapophysis, Xenicodinium, Fibrocysta, Hystrichokolpoma, Membranilarnacia, Senegalinium, Palaeocystodinium, Deflandrea, Ceratiopsis, Turbiospbaera, Lejeunecysta* and *Phrlodinium* in the succession suggests strong potential for demarcation of K/T boundary and integration of dinocyst data with other known plankton data and irridium peak documented from the same sequence. Photodocumentation and morphologic studies of a part of this assemblage have been done. A rare colonial algae referable to Chlorococcaceae (cf. *Palambagos*) is recorded from basal Langpar Formation.

Bibliography of geology and palaeontology of north-east India has been compiled and computerised.

K. P. Jain, Rahul Garg, N. C. Pant and A. S. Chopra

Project Sp. 7 : **All India Co-ordinated Research Project on Ethnobiology (D.E. no. 14/23/83-MAB/RE)**

An intensive scanning of the published records from 1873 up to 1987 and the ethnobotanical survey show that the number of plants used by the tribals and other communities in India to meet out their varied requirements exceed 6,000. Text of 532 taxa dealing with the methodology and techniques of the usage of plant parts, their regional names, the area and the reference of human communities using them, etc. have been prepared.

Some medicinal plants recovered from the earliest habitational deposit at Narhan (*ca* 1,000 B.C.) include remains of date-stone (*Phoenix dactylifera*), grape-seed or draksha (*Vitis vinifera*) and wood charcoals of Kuchla (*Strychnos nux-vomica*), tulsi (*Oscimum* sp. of *O. sanctum*) and gurch (*Tinospora cordifolia*). Crop remains from earliest habitational stratum (Pd. I) at this site (*ca* 1,000-800 B.C.) comprise kodon-millet (*Paspalum scrobiculatum*), pearl-millet or bajra (*Pennisetum typhoides*), horse-gram (*Dolichos biflorus*), lentil (*Lens culinaris*), moth (*Vigna aconitifolia*) and sesame (*Sesamum indicum*). Remains of fruits of ber (*Zizyphus* sp.), date (*Phoenix dactylifera*) and grape (*Vitis vinifera*) have also been reported.

Carbonised seeds and fruits belonging to 35 species of woods and other wild plants have been found mixed with the cultivars. They belong to *Fimbristylis tetragona, F. dichotoma, F. diphylla, F. spathacea, F. tenuicula, Rhyncospora hookerii, Cyperus* sp , *Elaescharis* sp., *Dactyloctenium aegyptium, Andropogon* sp., *Panicum* sp., *Conchrus ciliaris, Poa* sp., *Echinochloa crus-gulli, Polygonum barbatum, Rumex dentatus, Lolium temulentum, Amaranthus* sp., *Chenopodium album, Cucumis melo, Trianthema portulacastrum, Ipomoea pestigridis, Oldenlandia dichotoma, Argemone mexicana, Rhynchosia minima, Trigonella occulta, Vicia sativa, Indigofera linifolia, L. enneaphylla, Desmodium gangeticum, Lathyrus aphaca, Cleome* sp., *Sida alba, Malvastrum coromendalianum* and *Commelina benghalensis.*

Wood charcoals collected from different cultural horizons at Narhan in Gorakhpur District have been identified.

1. Black and red ware culture (Period—I): *ca* 1,000-800 B.C.—Dhak (*Butea monosperma*), Karanj (*Derris indica* syn. *Pongamia pinnata*), Bistendu (*Diospyros montana*), Mahua (*Madhuca indica*), Mango (*Mangifera indica*), Bahul/Khair (*Acacia nilotica/catechu*), Bamboo, Mulberry (*Morus alba*), holybasil (*Ocimum* sp.—cf. *sanctum*), Bakar (*Premna mucronata*), Sal (*Shorea robusta*), Kuchla (*Strychnos nux-vomica*), Imli (*Tamarindus indica*), Jhau (*Tamarix dioica*), Teak (*Tectona grandis*) and Gurch (*Tinospora cordifolia*).

2. Black-slipped ware culture (Period-II): C. 800-600 B.C.—*Acacia* sp., *Madhuca indica, Diospyros montana, Shorea robusta, Tamarindus indica, Tectona grandis, Mangifera indica,* Sissoo (*Dalbergia sissoo*), Anwala (*Emblica officinalis*), Kaim (*Mitragyna parvifolia*) and Jamun (*Syzygium cuminii*).

3. Northern Black-polished ware culture (Period-III): C. 600-200 B.C.—Punarnava (*Boerhaavia diffusa*), Dhaura (*Lagerstroemia parviflora*), Cheerwood (*Pinus roxburghii*) and Sandal-wood (*Santalum album*) are the new additions to the timber taxa in this cultural period. Mahua, Bamboo, Basil (Twig), Imli and Mango have also been found.

K. S. Saraswat, D. C. Saini and N. K. Sharma

International Geological Correlation Programmes

I.G.C.P. 216 —Global Biological events in Earth History

K.P. Jain, Assistant Director
Member, National Working Group

I.G.C.P. 237 —Gondwana floras

H.K. Maheshwari, Assistant Director
Co-convener, National Working Group

R.S. Tiwari, Assistant Director
Member, National Working Group

I.G.C.P. 261 —Stromatolites and their biostratigraphic significance

Manoj Shukla, Senior Scientific Officer
Member, National Working Group

Doctorate Degree Awarded

Mohan S. Chauhan —Ph.D., Lucknow University, Title of Thesis : "The origin and history of tropical deciduous forest in Madhya Pradesh"

Kalyan L. Meena —Ph.D., Lucknow University, Title of Thesis : "Biological life from the Precambrian of Vindhyans"

Mahesh Prasad —Ph.D., Lucknow University, Title of Thesis : "Studies on the plant fossils from the Siwalik Group"

Annamraju Rajanikanth —Ph.D., Lucknow University, Mesozoic flora from the Pranhita-Godavari Valley and East Coast of India"

Kamal J. Singh —Ph.D., Kanpur University, Title of Thesis : "Palaeobotanical contribution to the Kamthi Formation of India"

Abhay P. Srivastava —Ph.D., Kurukshetra University, Title of Thesis : "Fission Track studies on authigenic sedimentary mineral glauconite and its application to date Lower Vindhyan deposits"

Gyanendra K. Trivedi —Ph.D., Lucknow University, Title of Thesis : "Palynostratigraphy of Upper Eocene sediments in Meghalaya"

Doctorate Theses Submitted

Samir K. Bera —"Pollen productivity, dispersal and sedimentation in deciduous Sal forest, Sidhi, M. P., India".

Kindu L. Meena —"Palynostratigraphic studies of Permian-Triassic sediments in Raniganj Coalfield, India".

Ms Alpana Singh —"Palynology and maturation studies of Neyveli Lignite, South India".

Ms Rajni Tewari —"Contribution to palaeobotany of Permian Gondwana of India".

Papers Submitted

Agarwal, Anil—Occurrence of *Bouea* in the Neyveli lignite deposits, India. *Geophytology.*

Ambwani, K. & Kar, R. K.—SEM studies of some stratigraphically significant genera from the Tertiary sediments of India: *Dandotiaspora* and *Proxapertites. Pollen Spores.*

Ambwani, K. & Mehrotra, R. C.—A new fossil wood from the Deccan Intertrappean beds of Mandla District, Madhya Pradesh, India. *Rev. Palaeobot. Palynol.*

Awasthi, N. & Srivastava, Rashmi—*Canarium palaeoluzonicum*, a new fossil wood from the Neogene of Kerala with remarks on the nomenclature of fossil woods of Burseraceae. *Palaeobotanist.*

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Banerji, Jayasri, Lemoigne, Y., Le Nindre, Y. M., Manivit, J. & Vaslet, D.—Occurrence of Mesozoic plant remains from upper part of the middle Khuff Formation at Khashm Khartam, Quasim Province, Saudi Arabia. *Palaeobotanist.*

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Garg, Rahul, Khowaja Ateequzzaman & Jain, K. P.—Jurassic and Lower Cretaceous dinoflagellate cysts with some remarks on the concept of Upper Gondwana. *Palaeobotanist* 36.

Gupta, A.—Palynological evidence on the age of Jabalpur Formation exposed at the confluence of Harad and Sukkar rivers, Narsinghpur District, Madhya Pradesh. *Geophytology.*

Jafar, S. A. & Kapoor, P. N.—Late Maastrichtian-Danian nannoplankton from basal Subathu of Dharampur, Simla Himalaya, India—palaeogeographic implications. *Palaeobotanist.*

Khandelwal, A., Wadhwani, K. & Srivastava, A. K.—A preliminary report of airospora at two different altitudes of Amausi Airport, Lucknow, India. *Indian Archaeobiol.*

Maheshwari,, H. K. & Bajpai, Usha—Northern limits of the Eastern Gondwana : palaeobotanical evidence. *Palaeobotanist* 36.

Maheshwari, H. K. & Jana, B. N.—Palynozones in Jhuran and Bhuj formations in Kutch Basin. *Palaeobotanist* 36.

Maheshwari, H. K. & Tewari, Rajni—*Ancorisporites venkatachalae* sp. nov. from the Lower Permian of Bihar, India. *Palaeobotanist.*

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Navale, G. K. B. & Saxena, Rakesh—An appraisal of coal petrographic facies in Lower Gondwana (Permian) coal seams of India. *Int. Jl Coal Geol.*

Navale, G. K. B., Singh, B. D. & Misra, B. K.—The variable nature of the coal types, rank and formation of some of the Lower Gondwana coals in Son Valley, central India. *Econ. Geol.*

Pandya, Neeru—Geographic distribution of the genus *Cycadopteris* in Upper Gondwana. *Palaeobotanist* 36.

Pocock, S. A. J., Vasanthy, G. & Venkatachala, B. S.—Introduction to the study of particulate organic materials and ecological perspectives. *J. Palynol. Thanikamoni meml vol.*

Prasad, Mahesh—Some more fossil woods from the Lower Siwalik sediments of Kalagarh, Uttar Pradesh, India. *Geophytology.*

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Ram Awatar—Palynological dating of Supra-Barakar Formation in Son Graben. *Palaeobotanist* 36.

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Sukh-Dev—Floristic zones in the Mesozoic formations and their relative age. *Palaeobotanist* 36.

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Venkatachala, B. S. & Tiwari, R. S.—Gondwana marine incursions : periods and pathways. *Palaeobotanist* 36.

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Field Work

Anil Agarwal

Collected carbonised woods and leaf-impressions from the Neyveli lignite mines.

Ram-Awatar

Collected bore-core and outcrop samples from Sohagpur Coalfield, outcrop samples from near Nidpur Village along Gopad River Section and outcrop samples from Pali and Parsora type locality, Johilla Coalfield, Madhya Pradesh.

Rupendra Babu

Upper Vindhyan succession around Hoshangabad and Bhopal for macro- and micro-biota.

M. B. Bande

Collected fossil woods and trap samples from northern Karnataka.

M. B. Bande and C. M. Nautiyal

Collected trap and intertrap samples for radiometric dating from Shahpura, Mandla District, Madhya Pradesh.

Shaila Chandra, A. K. Srivastava and K. J. Singh

Plant fossils were collected from Raniganj Formation in Sidhi District and Talchir to Barakar formations around Umaria, Pali, Anupur and Chirimiri areas of Shahdol and Surguja districts.

Anil Chandra

128 rock samples belonging to nine deep wells of the Andaman Basin were collected from ONGC Laboratory, Madras.

H. P. Gupta and Asha Khandelwal

Collected two soil profiles one each from Balugaon and Nalabana Island and several surface samples and water samples within and around Chilka Lake.

S. A. Jafar and Jyotsana Rai

Systematic sampling and collection of field data in terminal Mesozoic and Tertiary of Jaisalmer Basin.

B. N. Jana

Collected palynological samples from Chakleshwari, Talbasta Mining region of

Athgarh Formation, Orissa.

R. K. Kar, J. Mandal and B. D. Mandaokar

Collected palynological samples from Disang and Jenam of Nagaland and Tikak Colliery, Assam.

Pramod Kumar

Collected rock samples from Than, Songadh, Tarnetar, Amrapara, Dhragadhra and Himmatnagar (Hathmati River Section) in Saurashtra Basin.

Kalyan Lal Meena

Vindhyan succession exposed around Maihar and Katni.

C. M. Nautiyal and A. P. Srivastava

Collection of glauconitic sandstones from Vindhyan deposits exposed at and around Chopan, Son Valley, Mirzapur District.

G. Rajagopalan and A. P. Srivastava

Sapotra-Karauli and Chittorgarh area, SE Rajasthan to collect glauconitic sandstone samples from the western part of Vindhyan Basin.

A. Rajanikanth

Coralline Limestone collection from the marine Cretaceous Sequence of Cauvery Basin, Tamil Nadu has been done.

D. C. Saini and N. K. Sharma

Collected plant remains dating from *ca* 1,000 B.C. to 600 B.C. from Narhan, District Gorakhpur.

R. K. Saxena, N. K. Misra and Sanjay Khare

Collected 97 samples from 11 localities in Ratnagiri and Sindhu Durg Districts of Maharashtra and 256 samples from 5 localities in Neyveli area, South Arcot District, Tamil Nadu.

K. J. Singh

Plant megafossils were collected from Ib-River Coalfield.

Manoj Shukla

Collected stromatolites and rock samples from Chitradurga, Sandur and Schimoga Schist belts.

Suresh C. Srivastava

Bore-core samples from Budharam, Mailaram, Koyagudem and Ainapallam areas

of Godavari Graben, Wardha Valley Coalfield and Kamptee Coalfield were collected for palynological studies.

B. S. Venkatachala, N. Awasthi, Samir Sarkar and Mahesh Prasad

Plant megafossils and palynological samples were collected from the Siwalik sediments of Suraikhola Sequence, Nepal.

R. R. Yadav and A. Bhattacharyya

Collected tree discs and tree stems for dendrochronological study from Chamoli and Uttarkashi in U.P. Himalaya and several sites in South India.

Papers presented at Symposia/Conferences/Meetings

K. Ambwani—*Palmoxylon hyphaenoides sp. nov. from the Deccan Intertrappean beds of Shahpura, Mandla District, Madhya Pradesh.* VII Indian Geophytological Conference, Lucknow.

Ram Awatar—*Palynological dating of Supra-Barakar Formation in Son Valley Graben.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

Jayasri Banerji—*First record of the genus Culcitites Appert from India and its significance.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

Usha Bajpai & H. K. Maheshwari—*Epiphyllous fungi from the Gondwana.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

A. Bhattacharyya—*Modern pollen spectra from the southern aspect of Rohtang Pass, Greater Himalayan Range.* VII Indian Geophytological Conference, Lucknow.

A. Bhattacharyya—*Prospects of dendrochronology in forest management in India.* Seminar on Tree Protection, Solan, H. P.

Shaila Chandra & Anil Chandra—*Vegetational changes and their climatic implications in coal-bearing Gondwana.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

Shaila Chandra & K. J. Singh—*Palaeobotany, age and climate of Handapa beds.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

Rahul Garg, Khowaja Ateequzzaman & K. P. Jain—*Jurassic and Lower Cretaceous dinoflagellate cysts with some remarks on concept of Upper Gondwana.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

Neerja Jha—*Palynology of Kamthi Formation in Godavari Graben.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

H. K. Maheshwari & B. N. Jana—*Palynozonation of Jhuran and Bhuj formations in Kutch Basin.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

H. K. Maheshwari & Rajni Tewari—*Megaspore biostratigraphy of the Gondwana. in Kutch Basin.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

H. K. Maheshwari & Usha Bajpai—*Northern limits of the eastern Gondwana in palaeobotanical evidence.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

P. K. Maithy & Rupendra Babu—*Macrobiota from Rohtas Formation, Son-Valley, Mirzapur District.* VII Indian Geophytological Conference, Lucknow.

P. K. Maithy & K. L. Meena—*Microbiota from the Vindhyan Supergroup of Satna-Maihar, M. P., India.* VII Indian Geophytological Conference, Lucknow.

J. Mandal—*Palynology of Palaeocene sediments from Thanjinath Hill, Meghalaya.* VII Indian Geophytological Conference, Lucknow.

B. D. Mandaokar—*Palynology of Miocene rocks around Maibong, Assam.* VII Indian Geophytological Conference, Lucknow.

Surendra R. Manik—*Seeds from Nidpur.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

K. Narain & P. K. Maithy—*Geology of Vindhyans around Rohtasgarh.* VII Indian Geophytological Conference, Lucknow.

Neeru Pandya—*Phytogeographic distribution of the genus Cycadopteris in the Upper Gondwana.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

A. Rajanikanth & Sukh-Dev—*The Kota Formation in fossil flora and stratigraphy.* VII Indian Geophytological Conference, Lucknow.

M. R. Rao—*Palynological investigation of a bore hole near Aruthangal in Alleppey District, Kerala.* VII Indian Geophytological Conference, Lucknow.

K. S. Saraswat—*Palaeoethnobotanical evidence of some herbal medicines from the Ghaghra Valley cultures of Uttar Pradesh.* VII Indian Geophytological Conference, Lucknow.

O. S. Sarate—*Miofloral succession during Lower Gondwana sedimentation in Satpura Graben.* VII Indian Geophytological Conference, Lucknow.

O. S. Sarate & G. V. Patil—*New miospore species recorded from the Permian sediments of Satpura Graben.* VII Indian Geophytological Conference, Lucknow.

Samir Sarkar, A. P. Bhattacharyya & Hari P. Singh—*Palynological investigations of Siwalik sediments from Bagh Rao, Uttar Pradesh, India.* VII Indian Geophytological Conference, Lucknow.

Rakesh Saxena & G. K. B. Navale—*Coal seam characterization in West Bokaro Basin, Bihar, India.* VII Indian Geophytological Conference, Lucknow.

Hari P. Singh—*Lower Tertiary palynology of northwestern India.* Proc. 75th Session, Indian Science Congress.

Hari P. Singh & B. S. Venkatachala—*Upper Jurassic Lower Cretaceous spore pollen assemblage in the peninsular India.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

A. K. Srivastava—*Morphology, evolution and insect/plant relationship in Lower Barakar flora of Raniganj Coalfield.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

Shyam C. Srivastava—*Stratigraphic position and age of plant-bearing Nidpur beds.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

Suresh C. Srivastava, Anand-Prakash & Trilochan Singh—*Permian palynofloras from the Eastern Himalaya and their genetic relationship.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

Sukh-Dev—*Floristic zones in the Upper Mesozoic formations and their relative age.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

R. S. Tiwari & Vijaya—*Reflection on relationship of Tethyan palynofloras.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

R. S. Tiwari & Archana Tripathi—*Palynological zones and their climatic inference in the coal-bearing Gondwana of the peninsula.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

B. S. Venkatachala—*Concepts, limits and extension of the Indian Gondwana—an introduction to the theme.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

B. S. Venkatachala—*Perspectives and new challenges in Indian Palaeobotany. Frontiers in Botany.* Platinum Jubilee Session of Indian Science Congress, Pune.

B. S. Venkatachala & R. S. Tiwari—*Gondwana marine incursions : periods and pathways.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

B. S. Venkatachala & A. Rajanikanth—*Stratigraphic implication of 'Late Gondwana' floras in East Coast.* Workshop : Concepts, limits and extension of the Indian Gondwana, Lucknow.

Lectures delivered

Rahul Garg—*Radiolaria and their significance in palaeoceanography.* Geology Department, Lucknow University.

H. P. Gupta—*Palynology : aspects and prospects.* G.S.I. Training Institute, Lucknow.

H. P. Gupta—*Palynology : its theory and application.* Utkal University, Bhubaneshwar.

G. Rajagopalan—*Dating of Quaternary sediments.* G.S.I., Northern Region, Lucknow.

G. Rajagopalan—*Techniques of dating and dating of archaeological material.* 10th UNESCO Training Programme, NRLC, Lucknow.

K. S. Saraswat—*Ethnobotanical aspects in archaeology.* All India Workshop on: Ethnobotany held at NBRI, Lucknow.

Rakesh Saxena—*Rock weathering.* 10th UNESCO Training Programme, NRLC, Lucknow.

Rakesh Saxena—*"Lupt ho rahi vanaspati".* All India Radio, Lucknow.

Chhaya Sharma—*Techniques for the study of plant fossils in Quaternary.* G.S.I. Training Institute, Lucknow.

Technical Assistance rendered to other Agencies

Training Provided

Mr Andrew Rozefelds, Palaeontology Division, Queensland Museum, Australia, in Jurassic-Cretaceous Palaeobotany.

Mr A. Narasimha Murty, College of Science and Technology, Andhra University, Andhra Pradesh, for Techniques of study of rock record.

Ms Rekha Dodia, Physical Research Laboratory, Ahmedabad, Quaternary Palynology.

Ms Sunita Singh, Department of Geology, Panjab University, Chandigarh, Diatom study of Quaternary sediments.

Mr S. Rabindranath, I.I.T. Bombay on Nannoplankton studies.

Dr T. S. Nayar, Tropical Botanical Garden & Research Institute, Kanamancode, Palode, Trivendrum, Kerala, Palynology of Quaternary sediments.

Mr S. C. Panda, Department of Botany, Utkal University, Bhubaneshwar, Orissa, Field training.

Technical Assistance

About 80 fossil wood specimens were identified for display in the Forest Range Office, Shahpura, Mandla District, Madhya Pradesh.

F-T dating of gabbro rocks was done for Oil and Natural Gas Commission, Dehradun.

Radiocarbon dating of samples for :

French Institute, Pondicherry

National Institute of Oceanography, Goa.

Geology Department, Panjab University, Chandigarh.

Department of Ancient History, Allahabad University, Allahabad.

Department of Archaeology, Banaras Hindu University, Varanasi.

Director, Department of Archaeology, Uttar Pradesh, Lucknow.

North-Eastern Circle, Geological Survey of India, Shillong.

Bore-core samples from Rajmahal, Raniganj, Panagarh Basins, Son Valley and Godavari Graben have been palynologically dated for Geological Survey of India.

Report on 3 bore-core samples has been submitted to Neyveli Lignite Corporation.

Work on Umaria, Korar and Rajmahal coals are being continued for Central Mining Planning and Design Institute of Coal India Limited.

Deputation/Training/Study Abroad

Jayasri Banerji

Visited University Claude, Bernard Lyon, 43, Boulevard du, France, during October 1986—April 1987 under French Government Fellowship.

M. B. Bande

Visited Section of Tropical Wood Anatomy, Museé Royal de la Afrique Centrale, Tervuren, Belgium during January—February 1988.

B. K. Misra

Training in Microphotometery on MPV3 Unit at Headquarter of Ernst Leitz, G.M.B.H., Wetzlar, West Germany during January, 1988. Visited coal Petrology Laboratory, Geologisches Landesamt, Nordrhein, Westfalen, Krefeld, West Germany.

Vijaya

Visiting Senckenberg Museum, Frankfurt, West Germany since September, 1987 on Alexander von Humboldt Foundation fellowship.

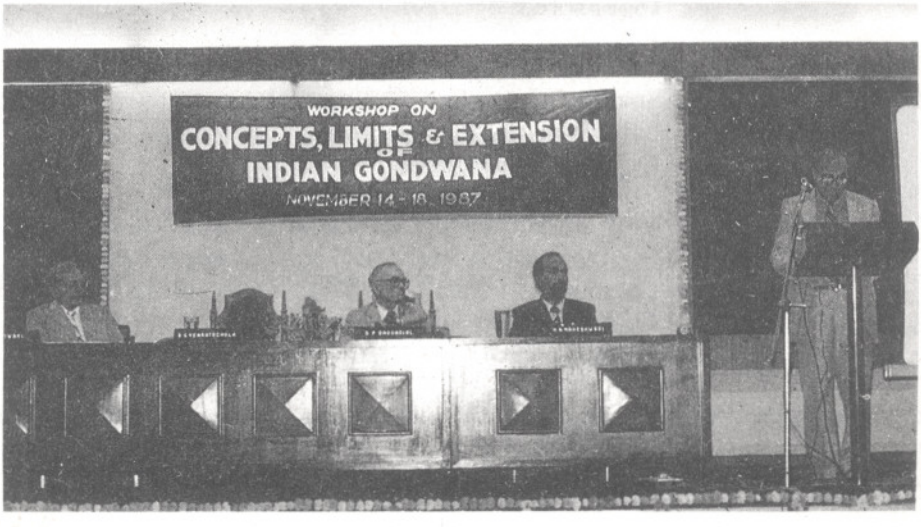
Courses/Lectures in the Institute by outside Scientists

Dr S. S. Iyer Central Drug Research Institute,	: Modern trends in information technology April, 1987
Dr R. Srinivasan National Geophysical Research Institute, Hyderabad	: Significance of biological signatures in Archaean sedimentary rocks of south India May, 1987
Professor A. K. Jain University of Roorkee, Roorkee	: The plate tectonic concept, geological frame work of the North-West Himalaya and significance of geochronology in geological history of the Himalaya June, 1987
Professor B. L. K. Somayajulu Physical Research Ahmedabad	: Quaternary dating and marine records July, 1987
Professor S. K. Tandon Delhi University, Delhi	Quaternary sedimentology—tectonics July, 1987
Professor S. N. Rajaguru Deccan College, Pune	: Quaternary Geomorphology July, 1987
Dr G. B. Pant Indian Institute of Tropical Meteorology, Pune	: Dendrochronology—climate patterns July, 1987
Professor K. S. Bawa Visiting Scientist, Professor of Biology University of Massachusetts Boston, MA 02125, U.S.A.	: Reproductive biology of lowland tropical forest trees, I—mating systems in forest trees, II—pollination mechanism, conservation and management of forest genetic resources March, 1988

Conference/Workshop sponsored

Workshop on—Concepts, limits and extension of the Indian Gondwana —November 14-18, 1987

VII Indian Geophytological Conference —November 28-30, 1987



Dr B. S. Venkatachala, Director, BSIP, giving an introduction to the workshop: Concepts, limits and extension of the Indian Gondwana.

Deputation to Conference/Symposium/Seminar/ Workshop/Expedition

Dr B. S. Venkatachala Dr R. S. Tiwari	National Symposium on Development of India's mineral and fuel resources, Geological and Environmental aspects, Dhanbad July 1987
Sri S. K. Bera	Multidisciplinary Glacier Expedition to Chhota Shigri (Sponsored by D.S.T.) July, 1987
Dr Manoj Shukla	Seminar in Modern Biology—Molecular Evolution, Mahabaleshwar, Pune October, 1987
Sri V. S. Panwar	Fifth Indian Society of Scientific Glass blowers annual Seminar, Department of Soil Sciences & Agricultural Chemistry, Tamil Nadu Agricultural University, Coimbatore October, 1987
25 Scientists presented research papers at the workshop :	Concepts, limits and extension of the Indian Gondwana, Birbal Sahni Institute of Palaeobotany, Lucknow November, 1987
14 Scientists presented research papers at :	7th Indian Geophytological Conference, Lucknow, Birbal Sahni Institute of Palaeobotany, Lucknow November, 1987
Dr K. S. Saraswat	Annual Conference of Indian Archaeological Society, Department of Ancient History, Culture and Archaeology, University of Sagar, Sagar December, 1987
Dr C. M. Nautiyal	4th National Symposium on Mass Spectrometry, Indian Institute of Science, Bangalore January, 1988
Dr B. S. Venkatachala Dr H. P. Singh	Indian Science Congress, Platinum Jubilee Session, Pune January, 1988
Dr Amalava Bhattacharyya	Seminar on Tree plantation, Solan March, 1988
Dr C. M. Nautiyal Dr Annamraju Rajanikanth	Workshop on Stereomorphometry used in Electron Microscopy, CDRI, Lucknow March, 1988

Publication

The Palaeobotanist

Volume 35 numbers 2 and 3 brought out.

Manuscripts of volume 36—a special volume on "Concepts, limits and extension of the Indian Gondwana" under process for publication.

Birbal Sahni Memorial Lecture

Sixteenth Birbal Sahni Memorial Lecture "Our oldest rocks and early record of life" delivered by Dr B. P. Radhakrishna, Geological Society of Bangalore was published.

Annual Report

Annual Reports, both in English and Hindi, were compiled and published. The publications of the Institute netted an income of Rs. 1,24,911.40 out of which about Rs. 70,750.00 were earned in foreign exchange approximately equivalent to US$ 4,306.60 plus £ 715.00

Library

The up-to-date holdings of the Library are as follows :

Particulars	Additions during 1987-1988	Total
Books	52	4174
Journals	229	8508
Reprints	372	31651
Microfilms/Fisches	—	290
Theses	5	68
Reports	—	46
Maps & Atlases	1	52
Reference Books	2	167

Sixty-nine current periodicals are being subscribed by the Library. The total number of registered borrowers is 131.

Exchange Programme

(i) Research papers of which reprints purchased	32
(ii) Reprints sent out in exchange	2358
(iii) Institutions on exchange list	59
(iv) Individuals on exchange list	448
(v) Periodicals on exchange list	70

Computerisation of Palaeobotanical References

A computer programme has been developed to retrieve references on different categories. All the reprints pertaining to Precambrian have been classified.

Herbarium

Reference collection of herbarium sheets, wood specimens, wood slides, polleniferous material, pollen slides, fruits and seeds comprises as follows :

Particulars	Addition during 1987-1988	Total
Herbarium sheets	180	11,298
Wood specimens	90	3,702
Pollen slides	—	11,384
Wood slides	160	4,340
Fruits and seeds	23	1,911

Two hundred herbarium specimens comprising about 180 species and 23 fruits and seeds were identified and incorporated in the collection.

Material Received from :

Department of Forest Products and Technology, Kangwoon National University, Korea	60 woods
Royal Forest Department, Thailand	30 woods

Material sent to :

Rijks Herbarium Leiden, The Netherlands	55 Indian wood samples
Termes Zettudomanyi Museum Budapest, Hungary	10 Indian wood samples
Forest Research Institute Dehradun	8 wood slides

Museum—A Fossil Repository

An exibition was arranged during the workshop on "Concepts, limits and extension of the Indian Gondwana", held at the Institute during November 14-18, 1987. The National Science Day was celebrated on 28 February, 1988 as an Open House. A catalogue of museum holdings of type and figured specimens and slides is under preparation.

Received type slides of two papers of Dr Arun Kumar of ONGC. Specimens and slides of *Cyclanthodendron sahnii* were sent to Professor P. B. Tomlinson of USA for his work on family Cyclanthaceae.

Type & Figured specimens/slides/negatives

Specimens/slides/negatives of 26 research papers were deposited with the museum.

	Additions during the year	Total
Type and figured specimens	126	4,225
Type and figured slides	165	9,307
Photo negatives	416	11,026

New Collections

Departments	*Specimens/Samples*	
Nonvascular Plants	69	02
Palaeophytic Evolutionary Botany	987	11
Cenophytic Evolutionary Botany	2,071	06
Quaternary Biogeography and Archaeobotany	—	113
Pre-Gondwana & Gondwana Palynostratigraphy	—	1,948
Post-Gondwana Palynostratigraphy of Peninsular India	—	1,120
Post-Gondwana Palynostratigraphy of Extra-Peninsular India	—	256
Planktonology	—	476
Radiometric Dating	—	57
Director's collection	—	08

Specimens/samples received for investigation—222

1. Archaeological Survey of India, New Delhi

2. Geological Survey of India, Camp Neyveli, Tamil Nadu
3. Physical Research Laboratory, Ahmedabad
4. Oil and Natural Gas Commission, Sibsagar, Assam
5. Precambrian Geology Division, Geological Survey of India, Hyderabad
6. Geological Survey of India, Orissa
7. Geological Survey of India, South Zone, Hyderabad
8. Geological Survey of India, Local Wing, Calcutta

Presentation of fossil specimens

1. Geology Department, Banaras Hindu University
2. Botany Department, Banaras Hindu University
3. Ramakrishna Vidhyashala, Mysore
4. Department of Botany, Garhwal University
5. Department of Botany, Aligarh Muslim University
6. S.S.L. Jain College, Vidisha
7. Sir Mathura Das Vissanji College of Arts & Commerce, Andheri East, Bombay
8. Department of Geology & Mineral Processing, Mandi hills, Sandur, Karnataka
9. Department of Botany, Kakatiya University, Warangal
10. Department of Botany, Dayal Bagh Educational Institute, Agra
11. Department of Botany, Meerut University
12. Neyveli Lignite Corporation Ltd.
13. Department of Earth Sciences, Roorkee University
14. Department of Geology, Government Science College, Jabalpur
15. Department of Botany, Visva Bharti University
16. Department of Botany, Sikkim Government College, Tadong

Visitors during the year

Educational Institutions

Darang College, Tejpur, Assam

Nalbari College, Nalbari, Assam

Botany Department, M. S. University, Baroda

S. N. M. College, Kaimganj, Farrukhabad

P. P. N. College, Kanpur

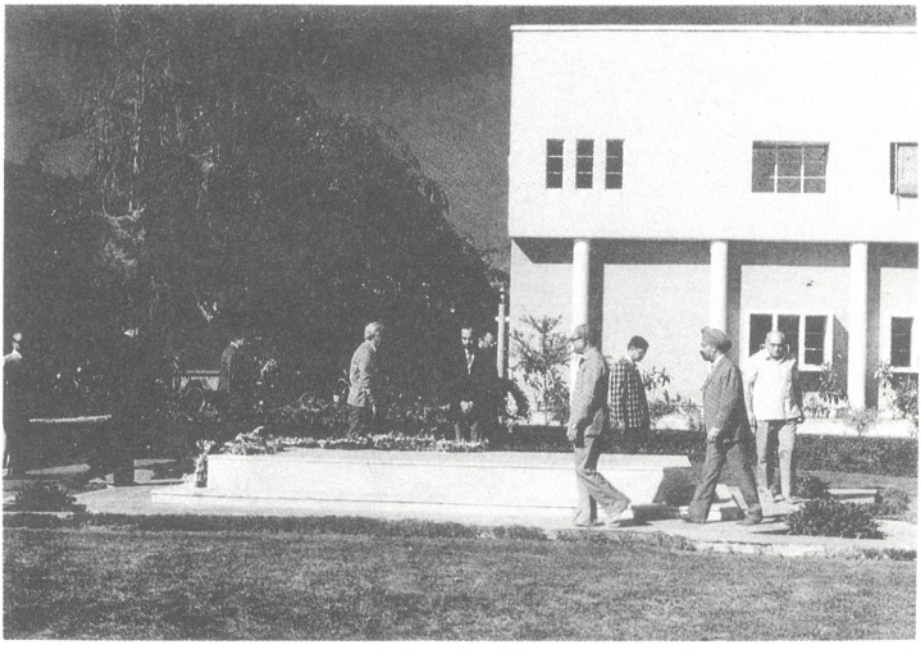
K. S. Saket P. G. College, Ayodhya

Distinguished Visitors

1. Professor Mark Baker, University of California, U.S.A.
2. Dr D. T. clarkson
3. Dr D. P. Dhoundial, Director-General, GSI, Calcutta
4. Dr G. K. Handique, O.I.L., Duliajan
5. Professor H. Krannich-Elke, West Germany
6. Professor R. R. Misra, NEHU, Shillong
7. Dr M. A. U. Mnclta, Chittagong, Bangla Desh
8. Dr T. S. Nayar, Trivandrum
9. Dr V. K. Nayar, ONGC, Baroda
10. Professor I. D. Pant, A.M.U., Aligarh
11. Dr Andrew Rozefelds, Queensland Museum, Australia
12. Dr R. T. Somaiya, Bombay
13. Dr V. C. Thakur, Director, W.I.H.G., Dehra Dun
14. Dr K. Thothathri, Jt. Director, BSI, Calcutta

Founder's Day Celebrations

The Birthday of the Founder, Professor Birbal Sahni, was celebrated on 14th November, 1987. The Institute staff and other distinguished persons offered "*Pushpanjali*" at the "Samadhi". In the forenoon, the workshop—Concepts, limits and extension of the Indian Gondwana, was inaugurated by Shri D. P. Dhoundial,



Paying homage at the Founder's *Samadhi.*

Professor T. S. Sadasivan delivering 17th Birbal Sahni Memorial Lecture—Why basic science?

Director-General, Geological Survey of India. In his inaugural address Shri D. P. Dhoundial emphasized on significance of geoscientific studies in relation to the Indian Gondwana. Introducing the theme Director Dr B. S. Venkatachala outlined the major problems in Indian Gondwana on which the participants were expected to deliberate. The same evening Professor T. S. Sadasivan, F.N.A. delivered the 17th Birbal Sahni Memorial Lecture—"Why basic science?".

Appointments and Promotions

Department of Post-Gondwana Palynostratigraphy of Extra-peninsular India

Dr H. P. Singh, Asst. Director, appointed as Deputy Director w.e.f 15.2.88

Dr R. K. Saxena, J.S.O., appointed as S.S.O. w.e.f 5.5.87

Department of Radiometric Dating

Dr G. Rajagopalan, A.D. appointed as A.D. (Spl. Grade) w.e.f. 15.2.88

Department of Pre-Gondwana and Gondwana Palynostratigraphy

Dr (Mrs) A. Tripathi, J.S.O., appointed as S.S.O. w.e.f. 5.5.87

Dr Vijaya, J.S.O., appointed as S.S.O. w.e.f. 15.2.88

Department of Post-Gondwana Palynostratigraphy of Peninsular India

Dr K. Ambwani, J.S.O., appointed as S.S.O. w.e.f. 5.5.87

Technical Cell

Dr Manoj Shukla, J.S.O., appointed as S.S.O. w.e.f 15.2.88

Department of Planktonology

Dr Rahul Garg, J.S.O., appointed as S.S.O. w.e.f. 15.2.88

Department of Cenophytic Evolutionary Botany

Dr J. S. Guleria, J.S.O., appointed as S.S.O. w.e.f. 15.2.1988

Accounts

Shri T. N. Shukla, Accountant, appointed as S.O.(F. & A.) w.e.f. 15.2.88

C.S.I.R. Projects

Phytoplankton biostratigraphy with emphasis on an integrated model for dating and biozonation—Assam Shelf

Sri N. C. Pant appointed as J.R.F. w.e.f. 14.7.87

Sri A. S. Chopra appointed as J.R.F. w.e.f. 26.10.87

Palynological dating and correlation of newly identified coal-bearing strata in Birbhum Diwanganj area, West Bengal

Sri D. K. Chowdhury appointed as J.R.F. w.e.f. 21.8.87

Palynostratigraphy of the Ratnagiri and Neyveli lignites and associated sediments

Sri Sanjay Khare appointed as J.R.F. w.e.f. 1.9.87

D.S.T. Project

Nannoplankton biostratigraphy and palaeoenvironment frame work of Cretaceous Palaeocene sediments of Andaman Islands

Sri O. P. Singh appointed as J.R.F. w.e.f. 21.9.87

Sri U. C. Mainali appointed as J.R.F. w.e.f. 27.7.87

Office

Sri Nafees Ahmad appointed as Driver w.e.f. 27.1.88

Retirements

Sri S. K. Suri, Deputy Registrar—31.7.87

Sri Ram Sahai, Mali—30.9.87

Obituary

Dr V. K. Singh, S.S.A.—22.7.1987

Sri Mahipal Singh, Mechanic—7.11.1987

Sri Bashir, Attendant—6.3.1988

Internal Committees

1. Faculty Consultative Committee

Nilamber Awasthi . . Chairman
Suresh C. Srivastava . . Secretary
A. K. Srivastava
Rahul Garg
Ms Asha Gupta

2. Joint Consultative Committee

Diwakar Pradhan . . Chairman
A. K. S. Rathore . . Secretary
L. M. Sanwal
N. K. Khasnavis
Pramod K. Bajpai
V. P. Singh
Mahipal singh
Ramesh Chandra
I. J. S. Bedi
Balbir Singh
Mewalal
Vishnu Kumar
Shatrughan

3. Research Programming Committee

B. S. Venkatachala . . Convener
H. K. Maheshwari
Nilamber Awasthi

4. Institute—University Interaction

K. P. Jain . . Convener

5. Inter-Institutional Interaction

H. K. Maheshwari . . Convener

6. Excursion Committee

K. P. Jain . . Convener
Suresh C. Srivastava

7. Instrument Maintenance Committee

K. P. Jain . . Convener
Anand Prakash

8. **Quality Control Committee**

M. B. Bande . . Convener
Bhagwan Singh
B. K. Jain

9. **Purchase Committee**

B. S. Venkatachala . . Convener
H. P. Singh
K. P. Jain
M. B. Bande
Registrar
Accounts Officer
Deputy Registrar (S)

10. **Continuing Education**

R. S. Tiwari . . Convener

11. **Maceration Committee**

Suresh C. Srivastava . . Convener
K. P. Jain
Avinesh Kumar Srivastava

12. **Scientific Display Committee**

Shaila Chandra . . Convener
Asha Khandelwal
Ms Sunita Khanna
P. K. Bajpai

13. **Building Construction and Maintenance Committee**

H. K. Maheshwari . . Convener
Anand Prakash
Registrar
Deputy Registrar (S)
P. K. Bajpai

14. **Vehicle Maintenance Committee**

Anand Prakash . . Convener
Registrar
Vehicle In-charge

15. **Garden Maintenance Committee**

R. K. Kar . . Convener
B. N. Jana
R. R. Yadava

Samir Sarkar
M. R. Rao

16. **Canteen Committee**

Sukh Dev	. .	Convener
Shyam C. Srivastava		
P. K. Bajpai	. .	Secretary
N. C. Saxena		
Ms Kamala Amarlal	. .	Treasurer
H. S. Srivastava		

Auditor's Report
of
Birbal Sahni Institute of Palaeobotany, Lucknow

We have audited the annexed Balance Sheet of the Birbal Sahni Institute of Palaeobotany, Lucknow as at 31st March, 1988 and also the relevant Income and Expenditure Account and Receipts and Payment Account for the year ended on that date with the account books, vouchers, information and explanations furnished to us.

We report that to the best of our information and according to the explanation given to us, in our opinion, the Balance Sheet read with notes thereon, shows a true and correct state of affairs of the Institute as at 31st March, 1988 and the Income & Expenditure Account gives a true and fair view of income over expenditure.

For R. N. Khanna & Company
Chartered Accountants

R. N. Khanna
Partner
M. No. F-13255

Notes on Balance Sheet of
Birbal Sahni Institute of Palaeobotany, Lucknow
as at 31st March, 1988

1. The Institute maintains the Accounts on cash system.

2. No depreciation are provided on fixed assets. The fixed assets are shown at cost.

3. In the absence of classified details of completed building works, the sum of Rs. 32,52,634.58 has been shown as "Building Works under Construction" Efforts should be made to classify the capitalisation under the various works.

4. The figures have been recasted or regrouped.

For R. N. Khanna & company
Chartered Accountants

R. N. Khanna
Partner

Place : Lucknow

BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, LUCKNOW

Balance Sheet as at 31st March, 1988

LIABILITIES	Rs.	ASSETS		Rs.
Capital	2,58,67,040.57	Land & Buildings		50,49,745.26
Advance Fund for Employees	17,90,656.00	Apparatus & Equipments		1,38,57,397.22
Excess of Income over Expenditure	14,84,649.14	Vehicles		6,51,398.57
		Furniture & Fixtures		17,48,206.11
Donated Funds/Gifts and Grants	4,09,348.40	Books & Journals		12,07,044.00
G.P.F./C.P.F. Provisions	41,72,604.37	Investments		80,687.50
Security/Earnest money Deposits	32,648.90	Advances due for recovery from Employees		41,45,186.10
		G.P.F./Investments		41,72,604.37
		Balance in hand :		
		Cash	185.15	
		Bank	28,43,700.08	
		UNESCO Coupons	793.02	28,44,678.25
Total :	3,37,56,947.38			3,37,56,947.38

Extract from Auditor's Report

We report that to the best of our information and according to the explanation given to us, in our opinion, the Balance Sheet read with notes thereon, shows a true and correct state of affairs of the Institute as at 31st March, 1988 and the Income & Expenditure Account gives a true and fair view of income over expenditure.

Sd/
For R. N. Khanna & Company
Chartered Accountant

Sd.
S. B. Verma
(Registrar)

Sd.
J. C. Singh
(Accounts Officer)

Sd.
B. S. Venkatachala
(Director)