PROGRESS REPORT

MAY 1981—MAY 1983

REGIONAL RESEARCH LABORATORY, BHOPAL

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LIBRARY BUILDING
BHOPAL UNIVERSITY CAMPUS
BHOPAL - 462 026
MADHYA PRADESH

FOREWORD

It is my privilege to present the first progress report on the work of the Regional Research Laboratory, Bhopal, of the Council of Scientific and Industrial Research. This report covers a two year period since the inception of this new laboratory in May, 1981 to May 1983.

A few years ago, it was felt that there should be a CSIR Research Laboratory in the State of Madhya Pradesh in view of its enormous untapped natural resources. The hope is that scientific studies on natural resources of the State would eventually lead to industries based on these resources. As a result a Committee was appointed by the M.P. State Government in 1974 in collaboration with CSIR. This Committee recommended the establishment of a Regional Research Laboratory at Bhopal to work on the mineral, forest and agricultural resources of the State. This report was further examined by a couple of other Committees, and the establishment of a full-fledged laboratory at Bhopal was finally approved in 1980.

Madhya Pradesh State Government kindly agreed to offer land and several additional infrastructural facilities to CSIR to set up the laboratory. CSIR has already purchased tenements from Housing Board and is in the process of acquiring BDA flats for housing of the staff. About fifteen thousand square feet of laboratory space has been already acquired at Bhopal for the work of the laboratory, including the space at Bhopal University and Maulana Azad College of Technology, Bhopal.

As a back drop, a study on Madhya Pradesh in the year 2000 has been completed by the laboratory to determine the research imperatives in the State, and to determine the research priorities for the laboratory. The laboratory will apply high science, including the best Scientists and the most sophisticated equipment, to develop information and technologies related to local resources which will have very large positive impacts on the development of the region and living standards of large masses. The laboratory hopes to develop new materials, new sources of energy, and new methods of conserving energy, which have never been developed heretofore.

The major thrust of this laboratory is to do research on mineral, forest and agricultural resources of M.P. to promote their uses as new materials and renewable sources of energy. Consequently divisions of Materials, Energy, and Systems Planning and Research Management have been created in the laboratory. The laboratory is expected to become a major centre of excellence in aluminium research in view of large bauxite resources of the region. The laboratory will have strength in microbial technology related to materials, materials

for energy, specially solar furnaces, and technology forecasting related to materials and energy.

A considerable amount of surplus equipment has been received from sister CSIR Laboratories and a lot of new equipment has been purchased or ordered. The laboratory now has facilities for microstructural examination of mineral and forest resources; for melting, casting and shaping of aluminium based composite materials; for physical, chemical, electrochemical and mechanical characterization of materials.

Salient features of the research activites are mentioned in detail in this report. Two major research projects on aluminium based composites and evaluation of mineral and forest based resources of M.P. have been initiated. Substantial work on synthesizing aluminium-ceramic particle composites from mineral resources of M.P. and characterizing their properties has been completed. Techniques to deposit several types of films on the surfaces of these composites have been developed for the first time. Physical and mechanical properties of certain natural fibres of M.P. have been determined for the first time, and they have been formed into composites with polymers. Studies on microbial degradation of paddy straw to extract silica have yielded interesting results.

The Scientists of the laboratory have already authored research publications in prestigeous international journals. Within this short span, the laboratory has also been contacted by several industries in the region for consultancy, trouble shooting expertise in the area of materials processing. A dialogue has been initiated with different agencies of M.P. State Government, and a number of them have expressed interest in utilising the expertise of the laboratory. Within the first two years of its existence, the laboratory has received a sponsored project from the DST on aluminium and a consultancy project from an industry on materials.

The laboratory has in this short time attracted reputed Scientists, Pool Officers, Research Fellows, Research Associates and Trainees. The laboratory is now poised to become a major accelerator of application of science in the development of the State. Already the library and other facilities at the laboratory are frequently being used by Scientists of the region.

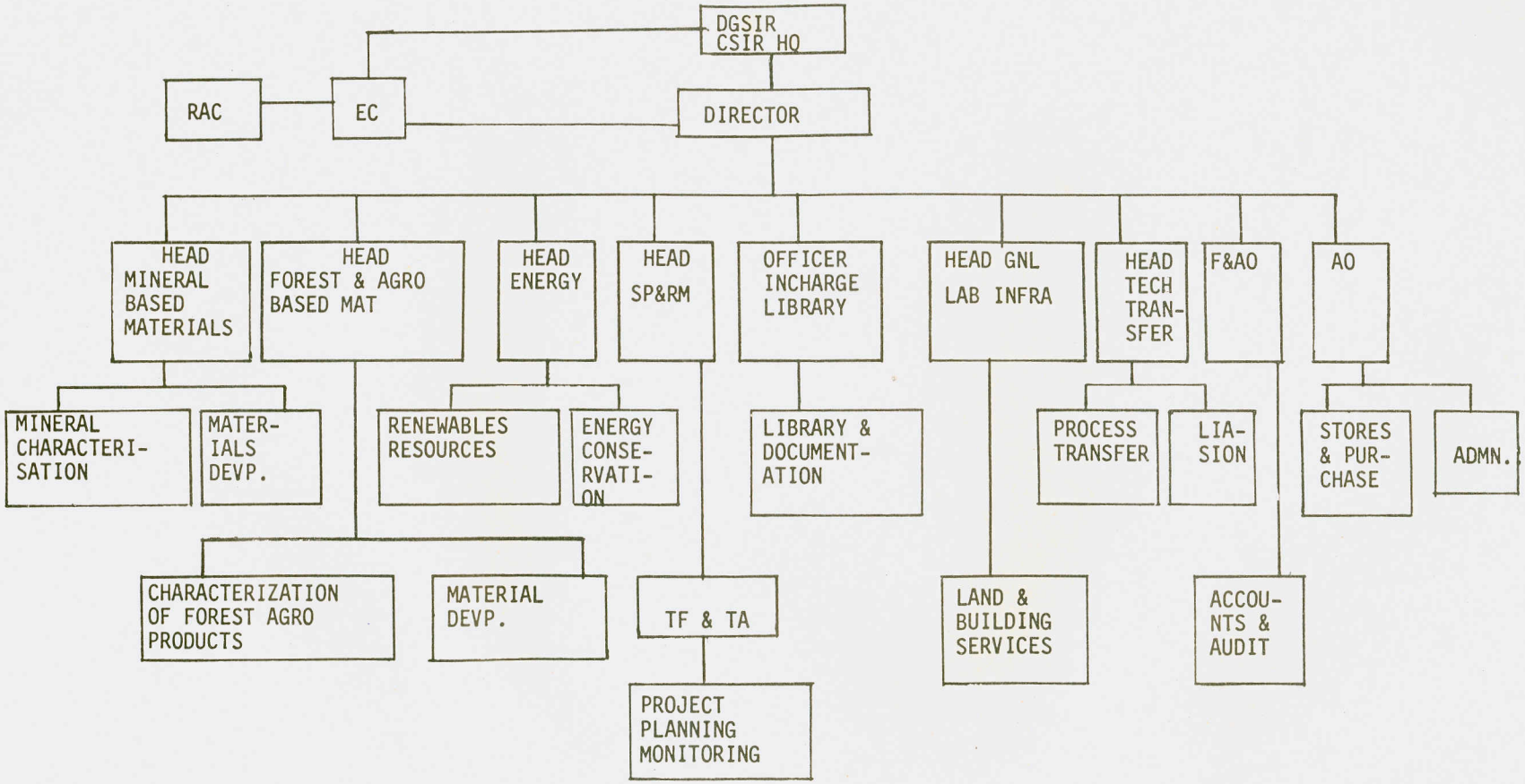
I wish to record our sincere appreciation for the support received from the Hon'ble Chief Minister of Madhya Pradesh, Shri Arjun Singh, and the State Government of M.P., and other academic and research institutions and industries in the Bhopal region in terms of their help in the establishment of this new laboratory. BHEL, Bhopal has extended generous support in terms of facilities for experiments on Al-based composites and studies on natural fibres. Similarly MACT, Bhopal, has shown a keen interest in collaborative research and offered facilities for work on the project of the laboratory. The help rendered by the sister institution like RRL, Trivandrum; CSIR-PTC, Bhopal; NAL, Bangalore; CEERI, Pilani; CECRI, Karaikudi; CSIO, Chandigarh; NPL, Delhi; NEERI, Nagpur; NBRI, Lucknow; NCL, Pune; IIT, Kanpur; IIT, Delhi; Banaras Hindu University and IISc, Bangalore is also gratefully acknowledged.

I am indebted to all my colleagues at RRL, Bhopal who have worked very hard to get this laboratory started. The guidance received from everybody in CSIR Headquarters in the establishment of this new laboratory has been very valuable. We are specially indebted to Professor Nurul Hasan, Vice-President, CSIR and Dr. G.S. Sidhu, Director-General, CSIR for taking personal interest in getting the infrastructural support for this new laboratory at Bhopal.

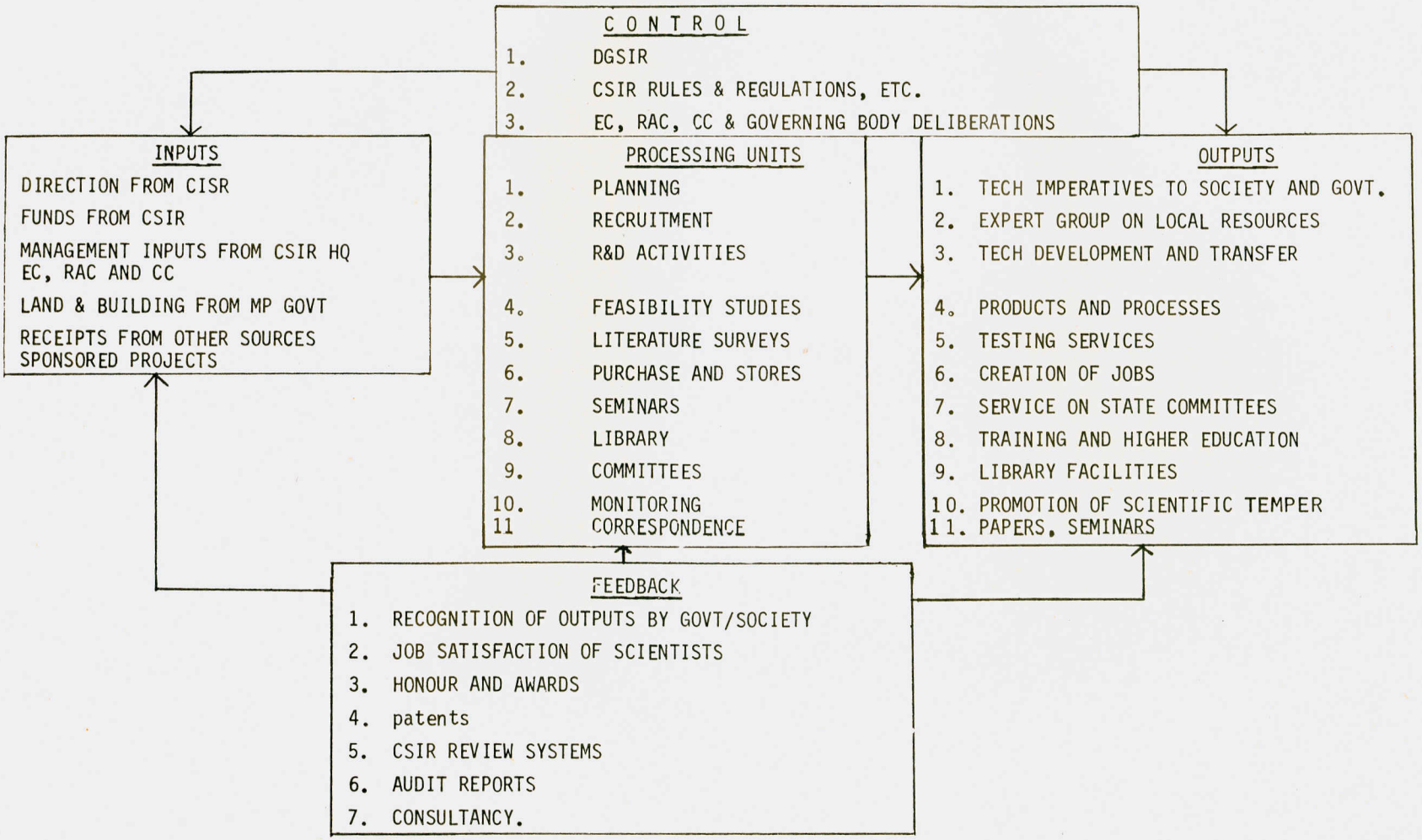
I am personally grateful to CSIR for entrusting me with the responsibility of setting up two of its research laboratories namely the Regional Research Laboratory, Trivandrum and the Regional Research Laboratory, Bhopal.

P.K. ROHATGI
Director

ORGANIZATION CHART OF RRL, BHOPAL



A SYSTEMS VIEW OF LABORATORY



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INTRODUCTION

The Council of Scientific and Industrial Research (CSIR) has set up a new Regional Research Laboratory (RRL) at Bhopal (M.P.). Madhya Pradesh, with an area of 4,42,841 Sq.Kms. is the largest State in our country. Its mineral and forest wealth is also amongst the richest, however, the resources have not been fully developed and exploited. A need, therefore, exists to develop industries based on these resources through the application of modern science, for raising the standards of living of the population. RRL, Bhopal will function to provide the much needed information and R&D inputs which will lead to development of technologies based on mineral, agricultural and forest resources. The State Government of Madhya Pradesh has offered two hundred acres of land and other infrastructure facilities for locating and setting up the laboratory at Bhopal.

The Director of the RRL, Bhopal, joined on 14th May, 1981 and subsequently a few Scientific staff were posted on transfer from sister CSIR laboratories and a camp office of the laboratory started operating from CSIR Headquarters, New Delhi.

The Bhopal University authorities generously offered the initial temporary accommodation to house the office and laboratories in their library building within the university campus, situated 15 Km. from the Railway Station on the Hoshangabad Road. Consequently, the office of the RRL, formally started functioning at Bhopal from October, 1981.

A BRIEF PERSPECTIVE OF THE LABORATORY

The State of Madhya Pradesh by virtue of its location in the centre of India and by vastness of rich natural resources can assume a significant role in industrial and technological development of the country. However, despite immense possibilities of establishing need-cum-resource based industries in M.P., the scientific and industrial development of the State has been less than desirable. In a recent survey on major scientific and technological institutions in the country it has been observed that there are very few institutions in Madhya Pradesh with a budget more than Rs.25 lakhs. This shows that M.P. with all its rich resources has not had the matching R&D inputs. Madhya Pradesh with its vast resources endowment including minerals, forest wealth and agricultural products, large geographical area and low population can provide exciting opportunities in the application of high level

modern science for the development of the State. The Regional Research Laboratory of Council of Scientific and Industrial Research at Bhopal will endeavour to:-

- become a centre of excellence in science to provide an opportunity for fulfilment of creative potential of scientists working on the resources of the region;
- become a centre of excellence in science related to development, specially a major accelerator of application of science and technology in the development and utilization of resources of the region;
- become a centre of scientific and technological information on material, forest and agriculture resources of the region;
- find new uses for mineral, agro and forest based resources of the region for meeting the needs of materials and energy through research and development;
- develop new uses and help in exploitation of unique minerals in Madhya Pradesh (e.g. lithium bearing minerals) which have not been exploited so far;
- become a major centre of excellence in aluminium in view of the large bauxite resources of Madhya Pradesh.

Attempts will be made to make breakthroughs in:-

(a) reducing the energy content of aluminium including the use of aluminium in transportation systems to conserve petroleum based energy, where the potential of foreign exchange savings can be several hundred crores each year;

(b) developing inexpensive aluminium equipment for tapping solar energy;

(c) developing inexpensive ways of producing aluminium-silicon alloys directly from bauxite in view of the almost unlimited availability of bauxite in Madhya Pradesh.

- develop solar and bio-mass energy for processing materials including the development of solar furnaces;
- characterize natural fibres and development of natural fibre products e.g. boards, table-tops, wall covers, roof covers and buckets, etc.;
- utilize agricultural and industrial wastes to develop new materials and renewable resources for energy;
- conduct forecasting and technology assessment excercises to derive industrial imperative for the region, and research imperatives for the laboratory, specially in the area of materials and energy based on local resources.

The laboratory will establish strong links with the State Government of Madhya Pradesh, sister scientific and technological institutions and industries in the region to identify demands for new technologies which should be developed and transferred for commercial exploitation.

A total systems approach in the form of interdisciplinary task forces is being nurtured to fulfil the objectives of the laboratory through application oriented fundamental research. The attempt is to develop simple technologies based on local resources using the most

modern science. These projects envisage a high level of creative intelligence, scientific pioneering spirit and awareness of socio-economic problems. RRL, Bhopal, aims at developing information and materials which are new on a world level, instead of merely reproducing what has been already produced elsewhere.

RESEARCH PROJECTS AND PLANS

Annual plans and a draft Five Year Plan from 1980-81 to 1984-85 for the laboratory, concurrent with the National Sixth Plan period have been prepared and the following two research projects have been initiated:

(1) Development and fabrication of Cast Al-based composites utilizing mineral, agro and forest based resources of Madhya Pradesh. Under this project aluminium-talc composite has been synthesized for the first time. Attempts are underway to synthesize aluminium-mica composites using locally available micaceous minerals. The technology of making aluminium-graphite castings is being upscaled.

(2) Evaluation of mineral and forest based resources of M.P. for identification of research, development and industrial imperatives. Under this project, a survey and evaluation of research opportunities based on minerals and natural fibres of M.P. have been determined and they have been combined with polymers, to form composites. A study on microbial degradation of paddy husk is underway.

The Department of Science and Technology, New Delhi, has sponsored a research project at the RRL, Bhopal on long range planning and techno-economic forecasting on aluminium towards the year 2020 A.D. The laboratory has received a consultancy project from a leading industrial group in the country to advise them on perspective planning studies in the area of Materials Research.

INSTITUTIONAL LINKAGES

RRL, Bhopal, has established very close contacts with the various Government, Semi-government and Autonomous Institutions and organizations engaged in development of Science, Technology and industrial potential of the State of Madhya Pradesh. Links have been developed with the various mineral, agro and forest based industries in Madhya Pradesh, in order to assess their R&D needs to possibly improve the quality of products and technologies used by them. In this connection Scientists from RRL, Bhopal, visited industries and other organizations in Raipur, Indore, Durg, Bhilai, Ratlam, Ujjain and Korba.

M.P. Council of Science and Technology, State Planning Board, Ministry of Industries, State Mining Corporation and M.P. Audyogika Vikas Nigam have taken keen interest in the activities of RRL. The laboratory is working out plans of collaboration with the State Planning Board, M.P. Audyogik Vikas Nigam Ltd., M.P. Laghu Udyog Nigam Ltd., Khadi Village Industries Corporation, Geological Survey of India and M.P. Energy Development Corporation. Useful contacts have also been established in Bhopal with Maulana Azad

College of Technology, Bharat Heavy Electricals Limited (BHEL), Regional College o Education, Central Institute of Agricultural Engineering, Bhopal University, Governmer Polytechnic and Technical Teachers Training Institute.

A formal collaborative programme on Tribo-Technology has been initiated wit IIT, Delhi. Collaborative programmes on composite materials have been initiated wi IIT, Kanpur, MACT, Bhopal, University of Roorkee, Banaras Hindu University and India Institute of Science, Bangalore. A number of discussions and lectures have been organise in the area of R&D activities of common interest. Groups of students and teaching staf members from local colleges and schools have visited the laboratory and derived inspiratio for scientific research. Local colleges have requested RRL, Bhopal to start research on the campuses to stimulate their students and staff. Many academic and research institutions a already making use of the limited facilities of the laboratory, specially its library. In th sense the Regional Research Laboratory is fulfilling its role as an accelerator of science an technology in this region.

A culture of seminars and group discussions has been nurtured to provide opportuniti for useful exchange of ideas and inhouse training to Scientists on latest developments i various fields of science and technology. RRL, Bhopal, is slowly getting known in th academic circles within the country and abroad and this will help in attracting high quali talent to the laboratory.

BUDGET AND EXPENDITURE

Table below gives expenditure figures of the laboratory.

Year	Total expenditure (Rs. in lakhs)	Remarks
1981-82	9.860	Actuals
1982-83	110.000	Actuals
1983-84	76.700	Sanctioned budget estimates

MANPOWER

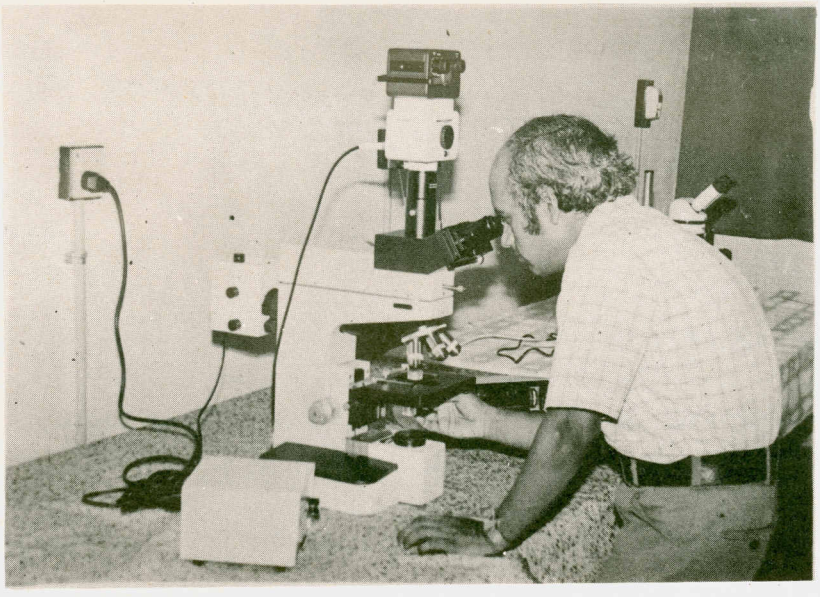
In December, 1981 the total staff was only six, comprising of Director, Adr inistrati Officer, two Scientists, a Research Associate and a Senior Research Fellow. The laborato now has twelve Scientists, one Emeritus Scientist, one Consultant, three Pool Officers a nine Research Fellows, including junior and senior Research Fellows and Research Ass ciates. The administration comprises six staff members. Steps have been taken for recru ment of additional manpower, specially top level scientific staff.

In consonance with the integrated interdisciplinary holistic approach, the Scientists have been drawn from various disciplines like metallurgy, ceramics, polymer science, civil engineering, chemical engineering, physics, chemistry, mathematics, bio-sciences and management sciences.

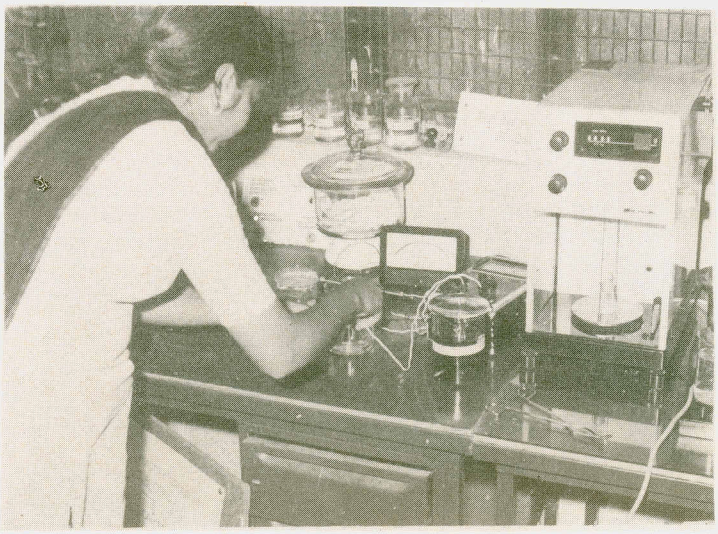
INFRASTRUCTURE DEVELOPMENT AND GROWTH

R&D ACTIVITIES

RRL, Bhopal, is being equipped with most modern scientific and analytical equipment and instrumentation to support the ongoing research projects and also to extend these facilities to help sister organizations and other industries in the region. A considerable amount of equipment offered by sister CSIR laboratories has already been acquired on transfer. These include equipment for foundry, composite-making, microscopes, electrical measurements, power supplies and instruments for chemical analysis like polarograph, pH meter, etc. Equipment and instrumentation facilities for a modern materials science laboratory specially for chemical and physical characterization, and for mechanical testing of materials is being procured. The new equipment already received include Compocasting furnace, Metallurgical polishing machine, Leitz metalloplan microscope, Stereomicroscope, Mounting Press, Damping capacity measurement equipment, Environmental Chambers for corrosion testing Centrifugal casting machine, Machine shop equipment, Resistance measurement equipment and equipment for testing properties of building materials. Orders also have been placed for Scanning Electron Microscope, INSTRON, Universal Testing Machine, Fatigue Testing Machine, Vicker-cum-Brinell hardness tester, Belt surfacer, etc.

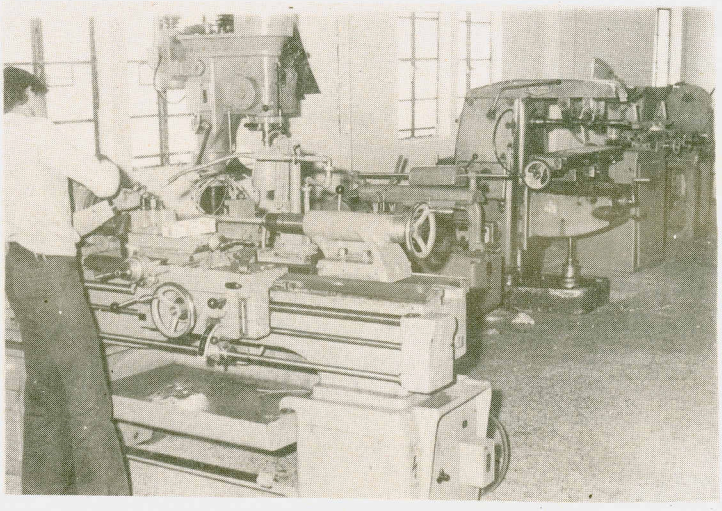


For chemical analysis carbon sulphur apparatus, pH meter, flame photometer, flask shaker, Flask heater, infrared moisture balance, analytical balances, electric air ovens, bomb calorimeter, visible spectrophotometer have been already installed.



One HCL-Workhorse Level-3 data processing unit is also purchased for the laboratory.

A central workshop facility is being created to support the research activities of the laboratory. Equipment like lathe, tool and cutter grinder, milling machine, power hacksaw, drilling machine, cutting machine, power drillers have already been installed.



LIBRARY AND DOCUMENTATION

A Central library of the laboratory which started in January 1982, now possesses a sizeable collection of latest books and periodicals. It holds the following documents:-

Total No. of books, standards and bound periodicals.	1331
Total No. of periodicals/journals Magazines subscribed	74
Total No. of Reprints/Articles	300
Total No. of Annual Reports	28
Total No. of books procured on inter-library loan	25
Total No. of bibliographies compiled.	3

In addition to the above, Annual Reports of various research institutions in the country are being received regularly. The library is also being equipped with a modern information and documentation system. The library has already become one of the premier sources of information on aluminium, composite materials, natural fibres, solar energy, solidification, foundry and technology forecasting.

Bibliographies on the researches in various fields like minerals of M.P., natural fibres of M.P., and metal-ceramic particle composite materials have already been compiled.

The RRL library has become a major centre of scientific and technical information for academic and research institutions in the region. Several scientists from sister institutions refer to the library of RRL, Bhopal, quite frequently.

A photocopier machine has been purchased and installed.

PROGRESS ON ESTABLISHMENT

The laboratory is presently housed in the library and boys hostel buildings of University of Bhopal. Additional space has been acquired in MACT, the Government College, Bhopal and in the city; the total working space available for the laboratory is about fifteen thousand square feet.

ACQUISITION OF LAND, CONSTRUCTION, ETC.

Possession of 97 acres land adjacent to University of Bhopal is being taken from the M.P. Government. In addition to this, negotiations are in progress for the transfer of about 60 acres of land in Maulana Azad College of Technology for RRL, Bhopal. The survey and contour plan and demarcation of land adjacent to University area has been completed.

RRL has purchased blocks of 24 single room tenements in Subhash Nagar, Bhopal, from M.P. State Housing Board. Possession of these houses has been taken from the State Government, and water and electrical supply has been installed in one block. Initial payments have been made to purchase BDA flats for housing of RRL staff.

RESEARCH IN PROGRESS

A brief report on the R&D activities under the ongoing projects is presented here.

ALUMINIUM BASED PARTICULATE COMPOSITE MATERIALS

The objective of this project is to optimise various process parameters for upscaling the technology of producing cast aluminium-ceramic particulate composites to industrial levels. New aluminium based composites using various natural resources of M.P. are also being developed through different techniques in the project.

A number of industries in the region manufacturing various aluminium based products e.g. Pistons, Bearings, etc. have been contacted. Accordingly, the laboratory has identified various products (Fig.1) where these composites, on account of their various attractive properties like antifriction, antiseizing, low coefficient of friction can easily substitute conventional materials. Addition of particulates, moreover, will reduce the density of aluminium alloys and decrease their cost by acting as filler. The composites are being synthesized at RRL, Bhopal, and local industries, and several industries like Scooters India Ltd., Lucknow, R.D.S.O., Lucknow, Premier Automobiles, Bombay, and Sah Industrial Institute, Varanasi have agreed to test these materials in their products.

Computations have been made for savings in fuel that can be achieved by using Pistons and Cylinder Liners of aluminium-graphite in transportation systems in the country

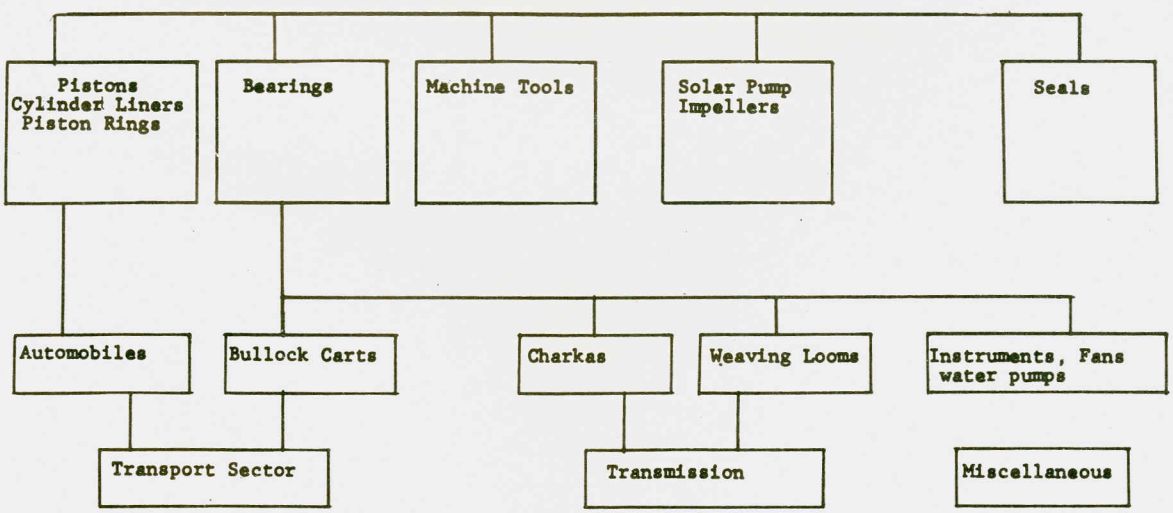


Fig. 1 : Major products of aluminium particulate composites

Table - I

Potential savings due to usage of aluminium graphite as Piston and Cylinder Linear material

Types of vehicles	Fuel Savings (By the year) Million litres				Savings in rupees (By the year) Rs. in crores			
	1986	1988	1990	1992	1986	1988	1990	1992
Cars and Jeeps	11.2	35.7	75.6	132.5	7.84	24.99	52.92	92.75
2 & 3 Wheelers	5.98	19.33	41.46	73.6	4.18	13.53	29.02	51.5
Other vehicles (Buses, trucks, tractors, etc.)	164.7	524.2	1112.2	1953.9	49.41	157.25	333.7	586.2
Total*	182	579	1229	2160	61	195	415	730

* Figures rounded off

(Table 1). These calculations indicate potential foreign exchange savings of several hundred crores per year due to savings in fuels, lubricants and scarce materials through the use of aluminium, specially aluminium-graphite composites developed in the laboratory.

Based on the present day melting and casting process of production of Pistons and Bearings, a proto-type furnace for making metal-ceramic particulate composites has been set up in the laboratory (Fig.2).

Process of dispersion of ceramic particles in metals faces the problem of non-wettability due to high surface tension of metal melts, and the contaminations on the particle surfaces. To a great extent, these problems have been overcome by altering the melt chemistry (by addition of alloying element like Mg) and pre-treatments on particles (Metal coating, pre-heating, etc.). It is, however, felt that to achieve control over distribution of particles during scale up to heats of different sizes and in making different castings, entry of the particles in the fluid and their movement in the melts should be understood in quantitative terms. Since cold models help in getting understanding of processes where fluid flow is involved, transparent model studies of movement of particles in fluids during mixing and casting have been initiated at RRL, Bhopal. Flow visualization, mixing and dispersion under various conditions of vessel geometry, and impeller design are being studied using transparent models. Simultaneously criterion for geometric, kinetic and dynamic similarily are being derived.

Aluminium-graphite composite utilizing graphite powder from M/s. Hindustan Electrographite, Bhopal, and aluminium-talc composites, utilizing talc powder from M.P., have been made. Typical photomicrograph of the aluminium-talc composites are given in Fig.3.

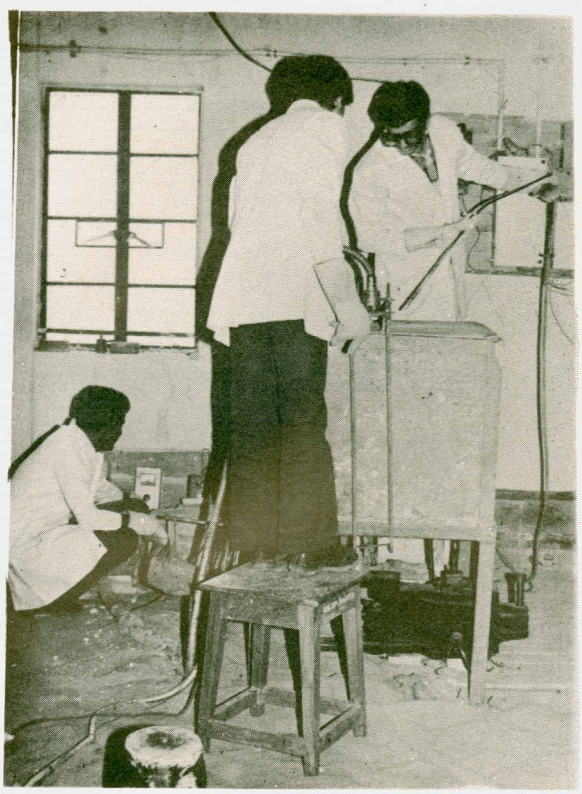


Fig. 2: A proto-type bottom pouring furnace for making cast metal/ceramic particulate composites with a Piston die at the bottom.

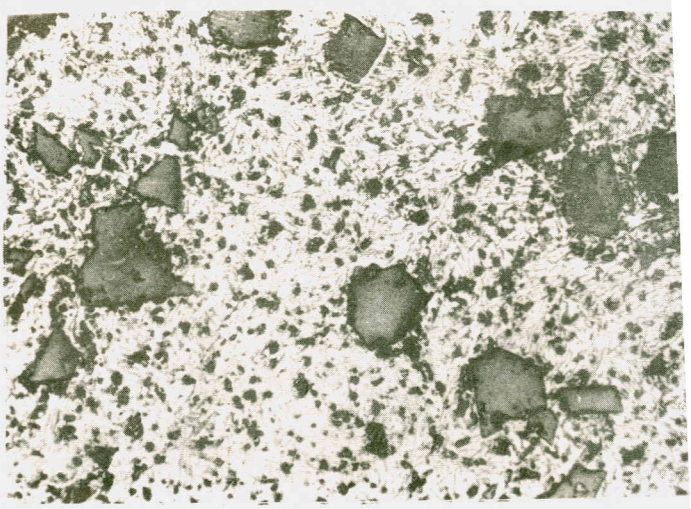


Fig. 3 : A typical micro-photograph of LM-13 alloy talc particle composite (X 165)

Detailed evaluation of properties of Aluminium-Ceramic particle composites is in progress. Towards this end facilities for measurements of damping capacity, thermal conductivity and resistivity have been created.

The ultrasonic velocity in Al-glass, Al-flyash particle composites has already been measured using the facility available at BHEL.

The composites like Al-graphite, Al-mica are characterised by high damping capacity. The ratio of specific damping capacity to density of Al-graphite composites is sufficiently high for the material to be considered fit for replacing cast iron in many applications where light weight is necessary. Measurements have been carried out to evaluate these values in composites, and in the base materials, using the damping capacity instrument set up in this laboratory (Fig. 4). For high frequency damping of mechanical waves, the ultrasonic attenuation has been measured. Table 2 lists some of the measured values.

Due to the presence of solid lubricant like graphite in Al-matrix, the composite exhibits superior antifriction properties, embedability and conformability. This leads to low coefficient of friction, low wear rates and resistance to galling. Higher wear resistance,

Table 2

	Log dec. torsion mode 10 Hz	Log dec. bending mode 1000 Hz	Ultrasonic attenuation Np/cm 10^6 Hz
Mild Steel	0.0110	-	0.057
Aluminium	0.0045	0.007	0.067
Al-graphite	0.0200	-	0.480
Cast iron	0.0560	-	1.050

Fig. 4 : Set up for measuring, damping capacity of composites at RRL, Bhopal.

conservation of fuel and lubricant can be achieved when frictional parts made of composites are employed.

The corrosion behaviour of aluminium graphite particulate composites in marin humid environments has been investigated at RRL, Bhopal. Experimentally it is conc that corrosion of composites is much faster in marine environment than in humid a phere or in oil baths.

An attempt has also been made to study the surface finishing of the alumi graphite composite materials. The composite samples were successfully plated with c ent metals e.g. copper, cadmium, zinc, tin, nickel, silver and gold by a modified me Besides this, electroless nickel plating was also tried out, which in some respects was to be better than electroplated nickel (Fig.5a). Anodising and dyeing of aluminium gra particulate composite were also successfully carried out (Fig.5b). These results ar portant since the coatings can mask the spotty effect due to graphite particles; thi requirement of some industries.

Rapidly solidified metals and alloys have evoked considerable interest in the las years because of their interesting properties such as high strength, better corrosion tance and soft magnetic properties. It also provides improved structure and prop through the production of fine dendrites and eutectics or through the reduction and nation of intercellular and interdendritic alloy segregation. RRL, Bhopal has started on the rapid solidification of aluminium based composite alloys. Fig. 6 shows the c nuous ribbons made by melt spinning technique of composite alloys.

Fig. 7 and Fig. 8 show the discontinuous ribbons of aluminium-graphite comp made by splat cooling and their microstructures respectively.

Fabrication of Al-based-composites by powder metallurgical route has been u taken as a collaborative work with IIT, Kanpur. Powders of aluminium alloy 2014 varying amount of metallic glass of composition Ni - 51.5%, Mo - 38.0%, Cr - 8.0%, B - were compacted, sintered and aged. Properties like dimensional changes, mechanical perties, microstructure were studied. It was found that composites with 4 vol. per ce metallic glass attained good properties.

Scanning electron microscopy, Electron Probe Micro Analysis (EPMA) and corr studies of these composites are in progress. Typical microstructure of composites nitrogen atmosphere sintering are shown in Fig. 9.

EVALUATION OF MINERAL RESOURCES OF MADHYA PRADESH

A statistical survey on mineral resources of M.P. has been undertaken with a view to ide and assess the research and development needs in this sector (Table 3).

An appraisal of current research on different minerals undertaken by different ratories has been completed to derive specific research imperatives for this laborator major thrust on bauxite and certain special minerals like lepidolite, cassiterite, talc, r

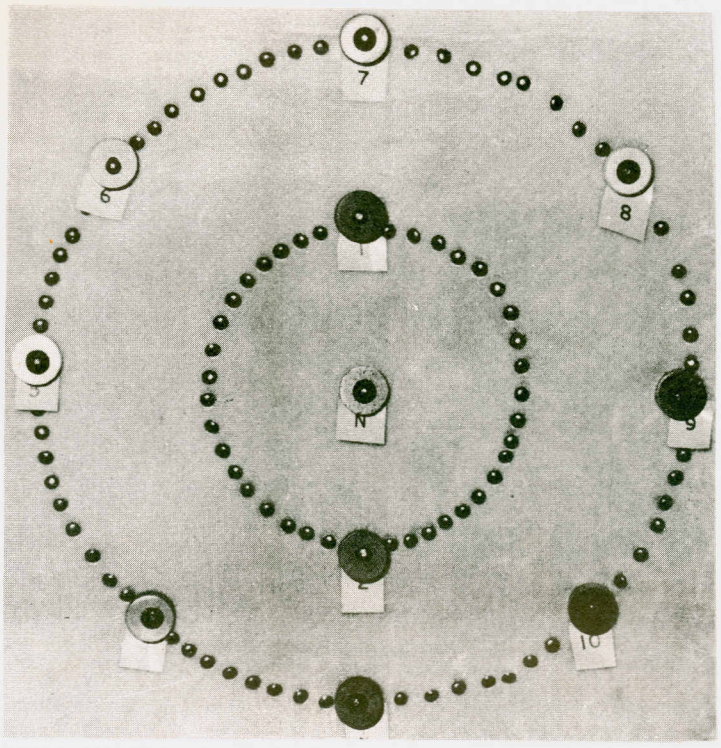


Fig. 5a : Aluminium-graphite with different types of surface finishes developed in the lab.

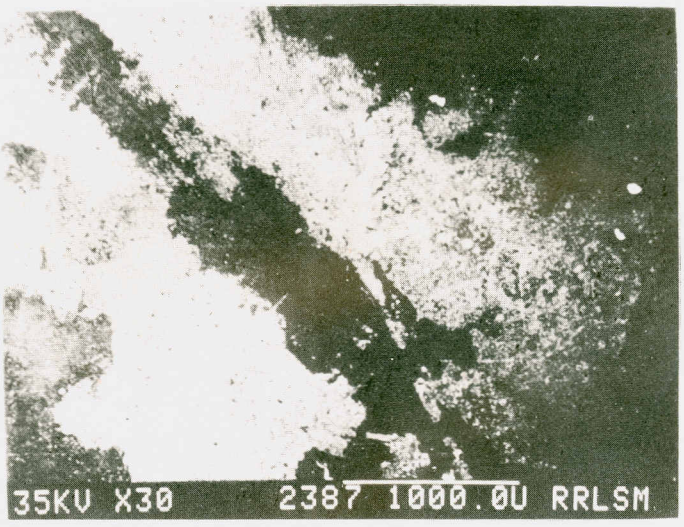


Fig. 5b : SEM picture: anodized and dyed aluminium graphite particulate composite 30 X.

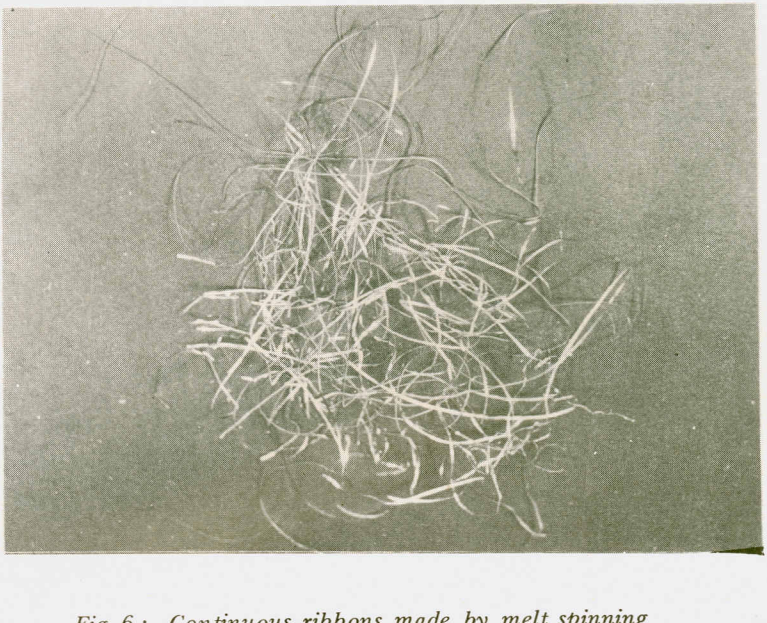


Fig. 6 : Continuous ribbons made by melt spinning of aluminium base composite alloys.

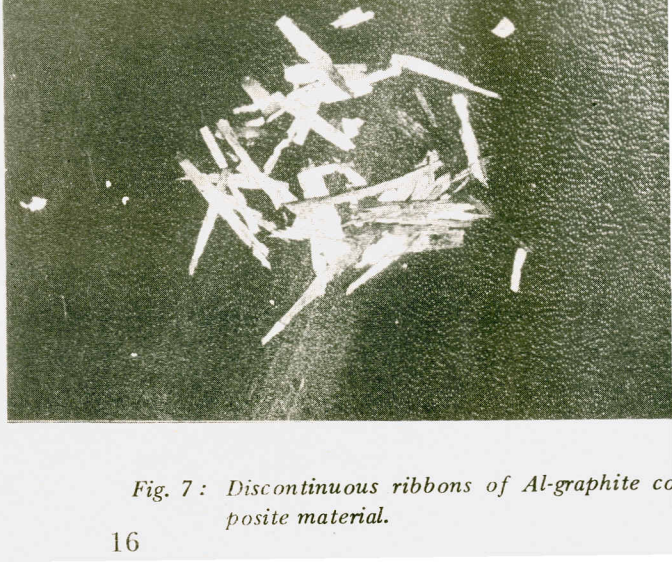


Fig. 7 : Discontinuous ribbons of Al-graphite co posite material.

Fig. 8 : A typical microstructure of ribbon made of Al-graphite composite material.

Fig. 9 : 2014 Al-alloy with 4 vol. % Met. glass X 400.

graphite and zeolite has been envisaged for studies at RRL, Bhopal. A group on microbial metallurgy will be set up to tackle the problems of removal of silica from bauxite, possibly coal and other minerals, and of phosphorus from manganese ores. In addition to these, an assessment of the industrial wastes in M.P. for instance fly-ash, red-mud, metallurgical and phosphorus slags has been completed. Samples of different minerals of the State have been collected and displayed at the laboratory.

Table 3

(In million tonnes)

	India	Madhya Prade
Apatite/Rock Phosphate	155.600	23.160
Barytes	73.387	0.094
Bauxite (Total)	2,489.117	187.464
Total met. grade	1,948.924	105.695
Refractory abrasive & met. mixed	4.615	0.565
Chemical grade	14.296	0.391
Unclassified & low grade	506.070	71.547
Copper	455.233	99.771
Corundum	3.940	1.680
Fire clay	359.500	121.100
Dolomite	4,948.300	1,726.210
Fluorite/Fluorspar	11.890	0.560*
Fuller's earth	133,458.840	117.200
Iron Ore		
Hematite	11,469.710	2,470.140
Magnetite	6,103.600	–
Kyanite	3,029.650	–
Limestone	73,199.850	8,213.000
Manganese ore	132.770*	65.000*
Molybdenum ore	8.637	8000 T only)
Sillimanite	11.996	0.105
Tin	1.752	1.752
Calcite	0.681*	0.048*
Coal	85,773.000*	8,773.000
Diamond	1.40 m carats	1.40 m carats
Graphite	172.890	0.530*

(Source – IBM Nagpur)

** DGM Raipur* *** Mineral Year Book 1977*

Bauxite

Bauxite ores of Madhya Pradesh consist mostly of metallic grade which accounts for near 60% of the total of all grades, and contain Al_2O_3 48-53% and SiO_2 4.5% max. Nearly or third of the known bauxite ore deposits are either unclassified or of low grade. India bauxite contain 70-100 ppm of gallium and 200 ppm of columbium which get concentrate in the liquor to recoverable quantities. However, lack of comprehensive mineralogic studies on a microscale is a major obstacle in economically extracting all valuable materia from bauxite.

Facilities for petrographic analysis of minerals, X-ray diffraction, derivatography, scanning electron microscopy (with microanalysis) are being established at RRL, Bhopal to complete the mineralogical assay of minerals. These will help in developing appropriate methods of beneficiation. To date microstructures of minerals such as bauxite, lepidolite, cassiterite of Bastar district and aluminous laterite of Amarkantak area have been studied at RRL, Bhopal using a mineralogical microscope.

Microstructure of bauxite occurring in the Bailadilla region was studied under petrographic microscope. The microphotography indicates (Fig.10a) colloform structure to the mineral and the presence of pisolites of aluminous laterite and transformation of aluminous laterite to gibbsite, colourless to pale brown (Fig. 10b).

The bauxite mineral contains massive bauxite also. Red-brownish colour is due to the presence of limonitic material $Fe(OH)_2$. The grains of black opaque mineral are that of either iron oxide or siliceous matter. It is necessary to carry on further studies to assess the mineralogical composition of the laterite mineral.

Megascopy of laterite (Amarkantak) shows that the sample is hard, massive yellowish to dark brownish, red rock. Microphotography of the sample (Fig. 11) indicates that the fraction consists of considerable portion of gibbsite, pisolites, ferruginous and aluminous laterites of variable sizes and also siliceous material (reactive and non-reactive silica). Dark and opaque grains are iron containing minerals. It shows that considerable portion of gibbsite and bauxite is going waste in the form of mine waste which needs proper study for

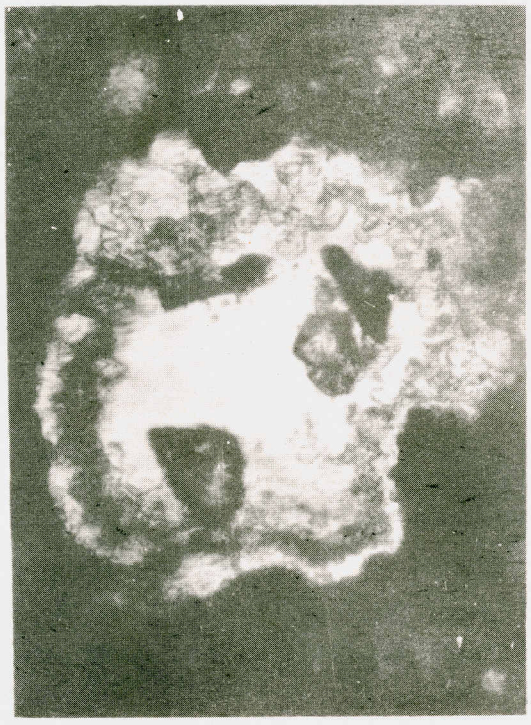


Fig.10a: Iron impurities in bauxite (colloform structure) X 40.

Fig.10b: Gibbsite in bauxite X 14.

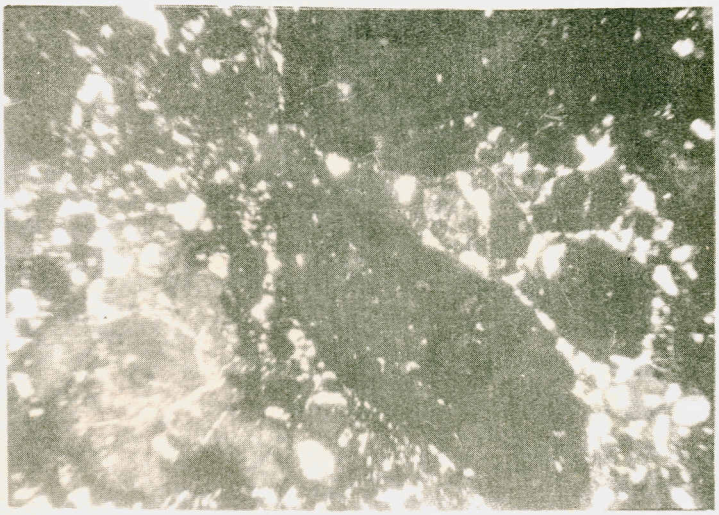


Fig.11 : Gibbsite in ferruginous laterite (Pisolitic) X 14.

utilization. It is, therefore, necessary to determine further the size of ferruginous and complete mineralogical identification by both physical and chemical methods.

Lepidolite

Lepidiolite of Bastar district contains approximately upto 1.8% lithium oxide. N have been made to extract lithium oxide from the mineral nor to directly use it fo glasses. RRL, Bhopal has started to study the microstructure of the mineral to w various methods of beneficiation and its utilization.

Lepidolite is colourless in thin section. When viewed through crossed Nicols, it birefringence and hence the interference colours range upto middle of third order (F

The main inclusion are quartz and iron (limonite) (Fig. 12b). It is necessary X-ray diffraction studies of the mineral and work out proper beneficiation technolog

Cassiterite (Tong Pal, Bastar)

Tin oxide is available in the form of cassiterite mineral in Bastar district. In the method of reduction of Tin oxide to the metal, there is a loss of nearly 40% of Ti goes waste in the form of slag. There are possibilities of finding some more reso cassiterite in the same district. Microstructure of mineral sample has been studied (F The microphotograph under crossed or plain polarised light exhibits all colours from less to reddish brown. It has also extreme birefringence but it is marked by the colour of the sample. The inclusions are ilmenite and cesium oxide (Fig. 13b). Th possibility of presence of radio active elements. Further studies on mineralogical terization of cassiterite are in progress.

Fig. 12a: Lepidolite (X Nicols) X 40.

Fig. 12b: Quartz in Lepidolite X 14.

Fig. 13a: An Optical transmission micrograph of cassiterite, X 14.

Fig. 13b: Black and opaque foreign particles alongwith tin oxide in cassiterite - X 40.

Table 4

I. Availability of major resources for fibres in Madhya Pradesh (1979-80)

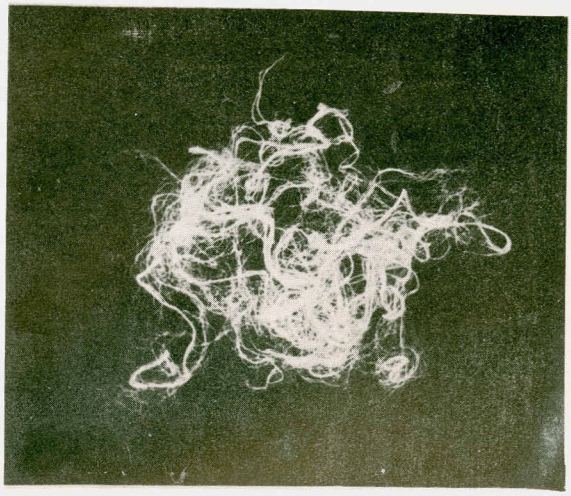
	Area under cultivation (000 hec.)	Production (000 tonnes)
Cotton	614.00	246.0*
Mesta	009.31	007.3
Banana (1.5% that of weight of stem)	009.00	220.0
Sunhemp	019.87	025.0
Sisal (1982-83)	000.144	000.00029
Palas (raw material for fibre)	Abundant	

II. Various other sources available in M.P. for obtaining natural fibres

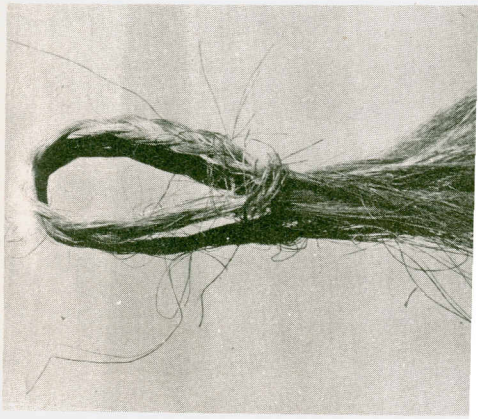
AAK. *Calotropis* sp.
Sal, *Shorea robusta* Gaertn.
Phalsa; *Grewia asiatica* Linn.
Banyan; *Ficus benghalensis*
Tur *Cajanus cajan* Linn.
Chakora; *Cassia-tora* Roxb.
Kachnar; *Bauhinia purpurea* Linn.
Bauhjnia rocemosa
Mahul, *Bauhinia vaheu*
Mung; *S. munga* Roxb.
Varieties of palm
Sida cordifalia
Semal Silk cotton tree
Kanghi *Abutilan indicum* Sweet.
Dhak; Palas. *Butea Monosperma* Lam.
Maror-phal; *Helicteres isora* Linn.
Alsi; *Linum usitatissimum* Linn.
Lady's finger; *Abelmoschus esculentus* Moench.
Pennisetum allopicuros
Erythria suberore Roxb.
Bauhiniya retusa
Hardwickia binata etc.
Kans; *Saccharum spontaneum* Linn.
Rice; *Oryza saliva*
Grasses
Karai; *Sterculia ureus* Roxb.
Bombax malabaricum
Jute; *Corchorius capsularis* var. *olitorius* Linn.

within a week for *S. thermophile* and *Pleurotus ostreatus,* but none for *Cyathus.* Within 30 days, considerable degradation was apparent (Fig.18). Fibres separation in case of paddy straw was extensive, and a dark brown fluid containing soluble fractions and cellulose and lignin degrading enzymes leached out into the liquid fraction. Microscopic observation (optical and scanning) showed extensive hyphal penetration, fibre separation, and a herring-bone skeletal structure which may represent silica. Attempts are underway to conform this.

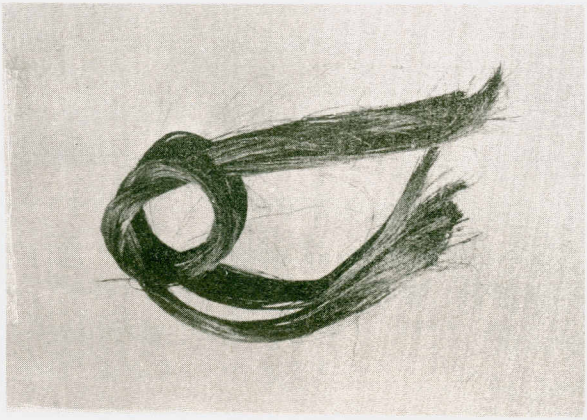
Further experiments have been planned to enhance the pace of degradation. The structure and reactivity of silica will be studied by chemical methods, X-ray diffraction, surface area measurement (BET), and scanning electron microscopy.



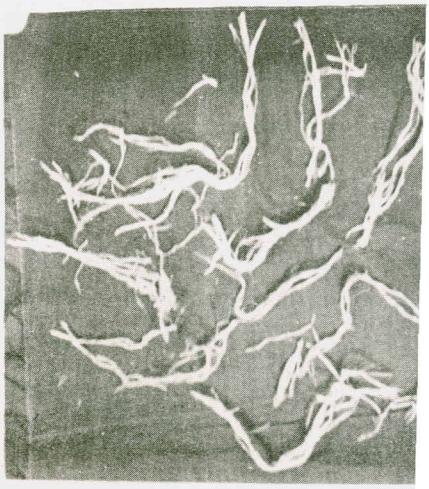
(a) Banana Fibre



(b) Sisal Fibre



(c) Sunhemp Fibre



(d) Palm leaf stalk Fibre

Fig. 14 : Photographs of some natural fibres available in M.P. region.

STUDIES ON FRESH WATER AND MARINE TURTLES

Studies on nesting and mating of fresh water and marine turtles have been star of marine turtles from Upper Lake, Bhopal, and Gahirmatha Lake, Orrissa, collected and they are being incubated to observe sex differentiation and inner gonads and hearts. Materials Science studies on carapace of turtles are in progress.

ACTIVITIES IN BUILDING MATERIALS RESEARCH

RAC of RRL, Bhopal, at its first meeting recommended exploring the possibility taking activity in Materials Science of building materials. In a number of seminars

Fig. 15a: Cross-section of Sunhemp Fibre - X 200.

Fig. 15b: Fractured surface of Sunhemp X 400.

has been focused about housing which still remains immediate problem of our country. Hence greater attention wll be paid to science of materials based on local resources which are used for construction by large numbers of poor people (Fig. 19). Besides, development of building materials, local problems facing M.P. such as construction on black cotton soil which give rise to foundation problems and cracking in the buildings will also be investigated. The group on building materials science is proposing to organise a workshop in collaboration with Central Building Research Institute, Roorkee, to identify problems related to construction and also development of cheap building materials using local materials including fly-ash, red mud, wastes forest products and organic fibres.

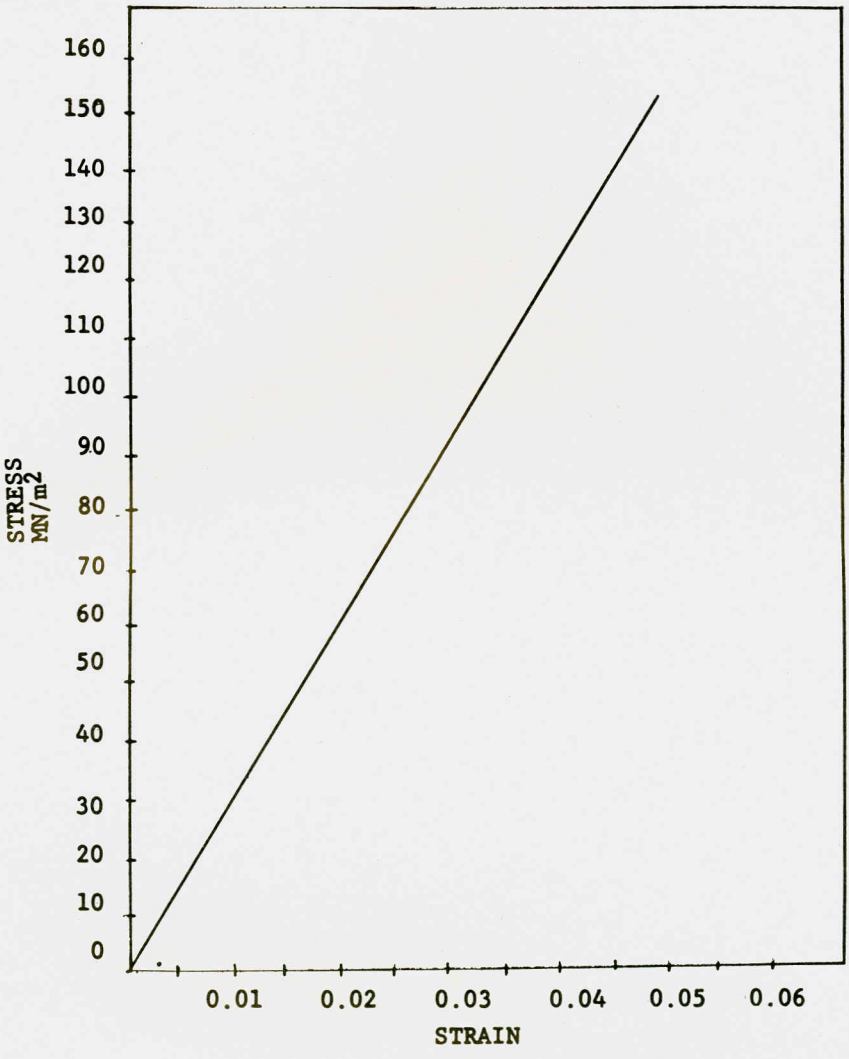


Fig. 16 : Stress-Strain Curve of Sunhemp.

A FORECASTING STUDY OF M.P. TOWARDS THE YEAR 2000 A.D.

M.P. State Planning Board has shown interest in having RRL, Bhopal to conduct persp planning studies in following areas for the State of M.P.:-

(1) Mineral development
(2) Forest development & Forest based industries
(3) Agro waste based industries
(4) Industrial development of state.

The Research Advisory Committee of RRL also considered the work initiated above regard and approved the same.

Accordingly, a techno-economic forecasting study of M.P. towards the year 200 has been initiated. Using extrapolative and normative techniques as applied in Tech

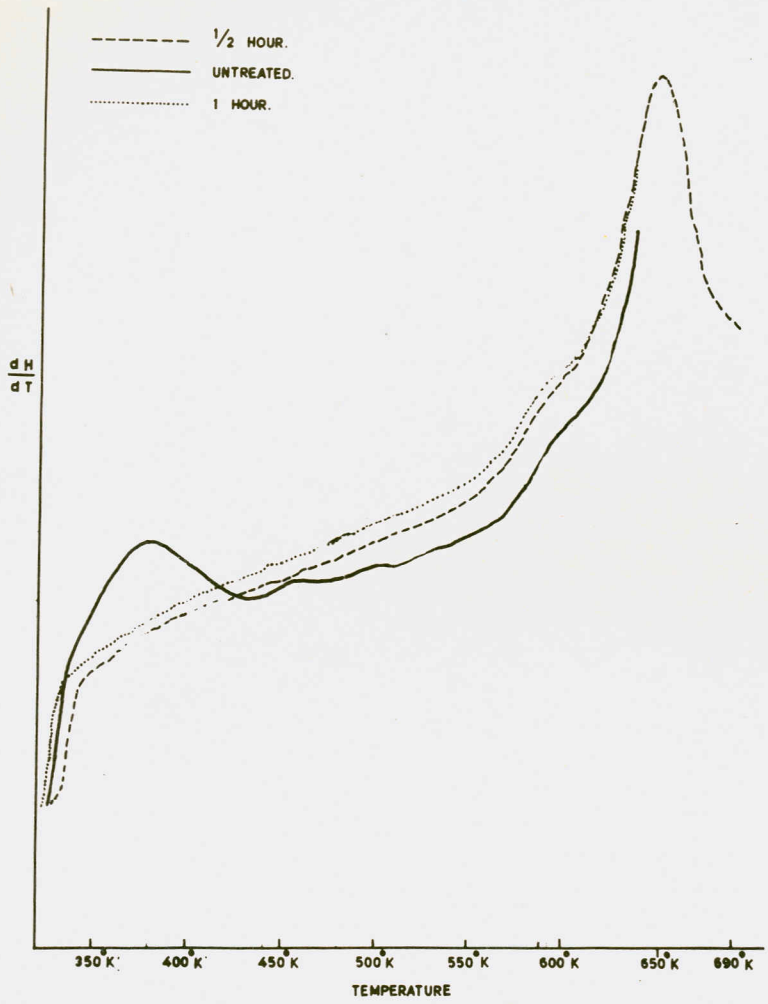


Fig. 17: Typical dH/dt vs. Temp. plot for Sisal

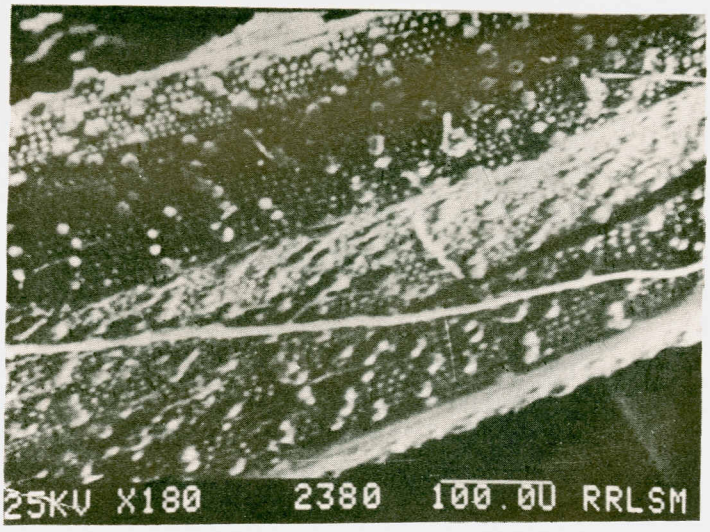


Fig. 18 : SEM picture of microbially degraded paddy husk.

Fig.19 : Typical plant based roofing materials used extensively in M.P. Research to increase the performance of such roofs is underway.

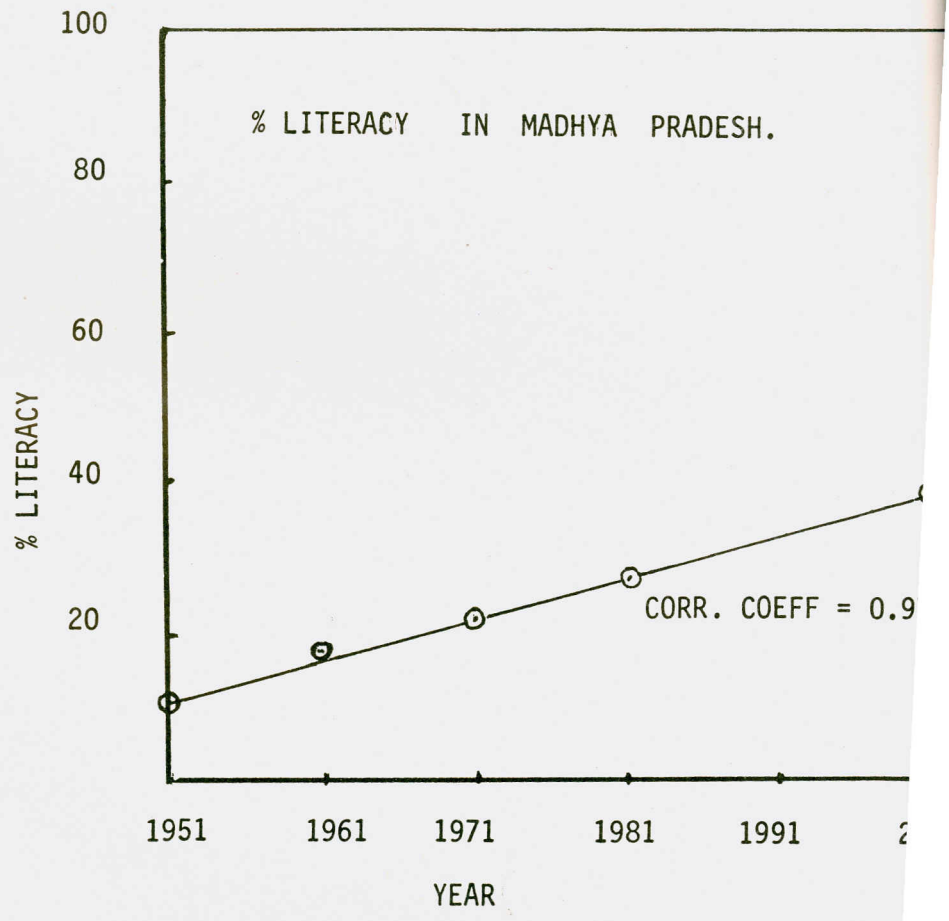


Fig.20 : Trends in literacy in Madhya Pradesh.

Table 5

Plant containing siliceous material available in M.P. (1979-80)

(In 1000 tonnes)

I	Rice Straw	3652	Rice Husk	456.5
	Wheat Straw	4310	Maize Straw	1082
	Maize Corns	541	Jav.ar Straw	5545
	Barley Straw	180	Tur Straw	459
	Sugarcane bagasse	333		

II Various other siliceous plants available in M.P.

Sagwan	-	*Tectona grandis* Linn
Lasoda	-	*Ficus heterophylla*
Jai	-	*Avena sativa* Linn.
Kanta Bans	-	*Bambusa arudinacea* Retz.
Bans	-	*Dendrocalamus strictus* Nees.
Doob	-	*Cynodon dactylon* Pers.
Munj	-	*Saccharum munja* Roxb.
Sankru	-	*Coix lachryma-jobi* L.
Sukal	-	*Andropogon contortus* R&S
Mottiburu	-	*Aristida adscenscionis* Linn.
Dhooria	-	*Eragrostis tenella* Beauv.
Sonthi	-	*Ophiurus corymbosus*
Kiwai	-	*Digitaria setigera* Roth.
Lamp	-	*Eragrostis diarrhena* Schult .
Thingri	-	*Eleusine indica* Gaertn.
Baria	-	*Dinebra arabica* Beauv.
Alang-alang	-	*Imperata cylindrica* Beauv.

forecasting, estimates of population, population density, occupation rates, literacy, food production, state domestic product (SDP), forestry, industrial production towards 2000 A.D. have been made (Figs. 20, 21 and 22). Also, an analysis of the economy of the State through data on State income (70-71 prices) has been done. Following table shows some of the forecasts made using extrapolation technique for the State of M.P. towards the year 2000 A.D.

Efforts are being made to prioritize policy options and to identify specific research and development imperatives for M.P. using these forecasts. A few important recommendations of the study are mentioned below:-

(1) An occupation rate of atleast 30% has to be targetted and secondary sector must be energised to create additional job potential of 12 million by the year 2000 A.D.

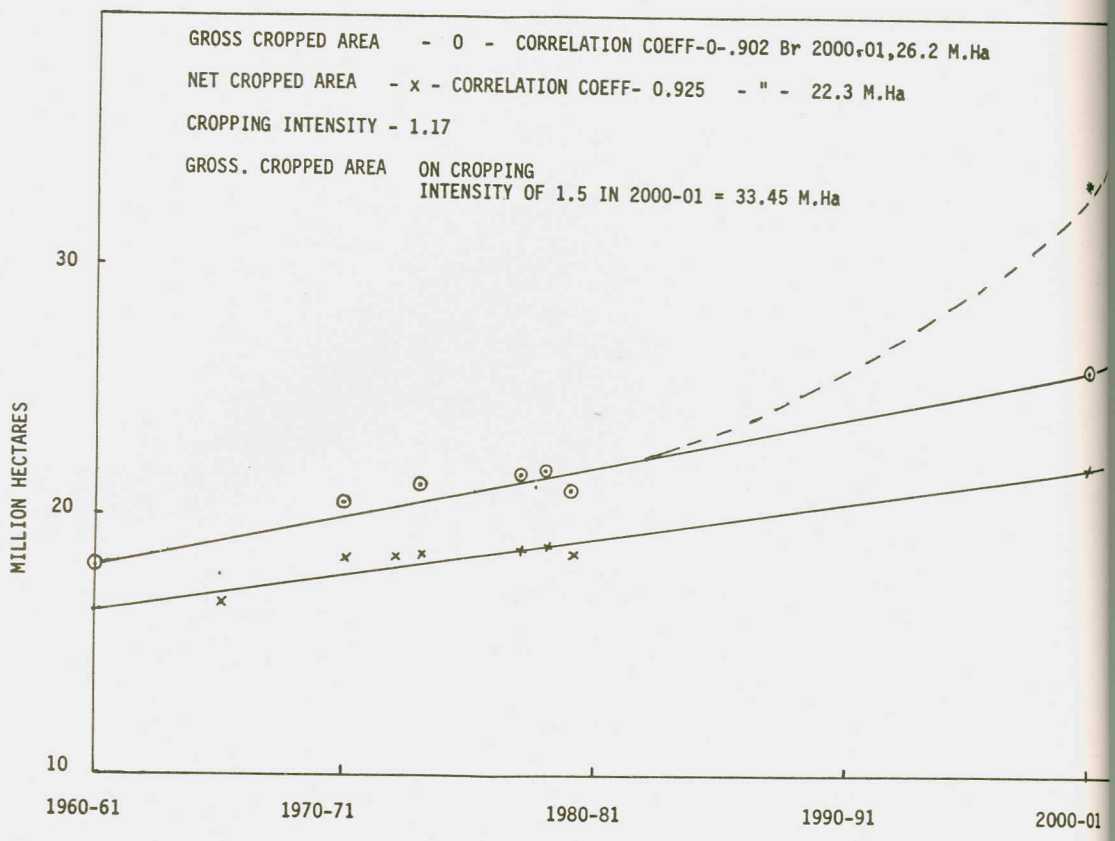


Fig.21 : Trends in cropped area in Madhya Pradesh.

(2) Contribution to the State Domestic Product from primary sector of agricult and allied activities will be dominant. But this has to be increased multif through improved performance which is well within the realm of reality.

(3) Secondary sector must be supplimented by an additional impeteous in the St plan. Also services sector should be controlled in consonance with the manuf turing sector to avoid inflationery trends in economy.

(4) Literacy rates have to be multiplied by additional inputs in education planni of the state.

(5) Planned land use, multiple cropping, judicious application of fertilizer, fa mechanisation and adequate tapping of irrigation potential.

(6) Modern methods of forest management to tap full potential of M.P. fores

(7) Promote indegenous utilization of natural resources, value addition through r material processing within the State. Better use of science and technology accelerators for development through increased R&D inputs.

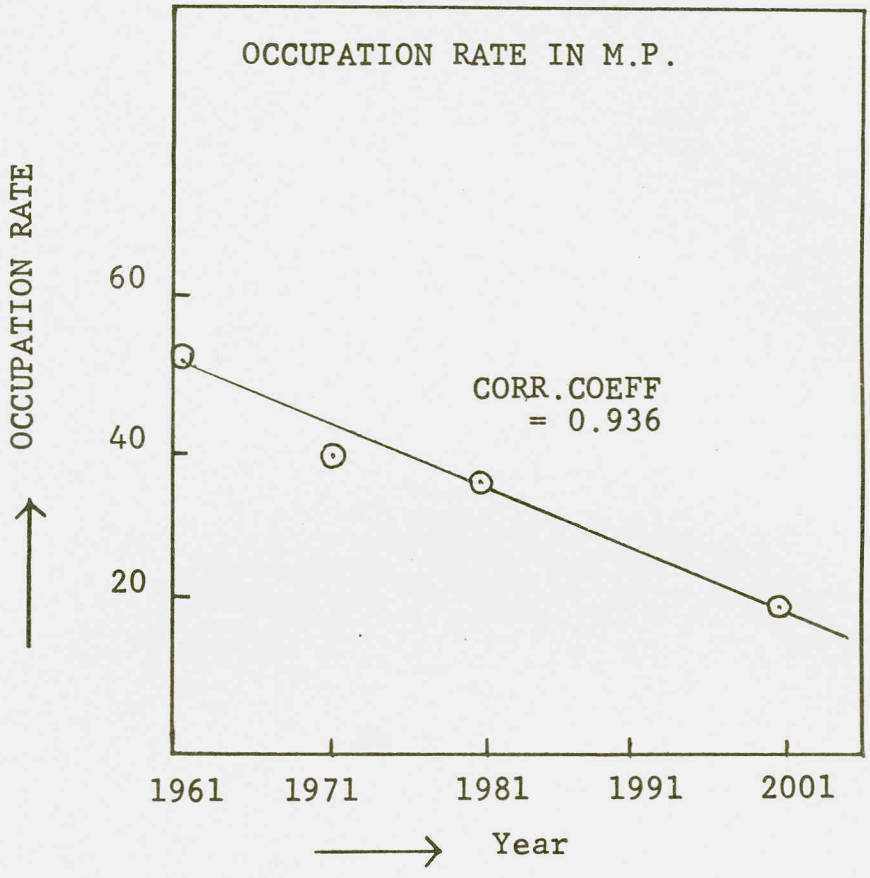


Fig.22 : Trends in occupation rates in Madhya Pradesh.

Table 6

Likely State of Madhya Pradesh by 2000 A.D.

	Present status	By 2000 A.D. (extrapolated)
Population (million) 1981	52.13	75.00
Population density (persons per sq.km.) 1981	118.00	165.00
Birth rate per 1000 population (1981)	37.80	30.00
Death rate per 1000 population (1981)	15.10	9.00
Literacy (%) 1981	27.82	39.50
Occupation Rate (%) 1981	36.70	20.00
Net cropped area (million hectares) 1979	18.511	22.30
Gross cropped area (million hectares) 1979	20.938	26.20
Total forest area (million hectares) 1979	1.563	1.37
Production of Newsprint (1000 T) 1979	48.421	88.28
Per capita elec. consumption kwh/year (1980)	99.00	200.00

In view of the above imperatives, the RRL, Bhopal is focusing on developing tech
logies that will be based on local resources, result in value addition within the State,
will preferably constitute secondary processing.

EXCHANGE PROGRAMMES, AND CONSULTANCY

VISITS BY FOREIGN SCIENTISTS

Dr. J. Paul Pemsler, President, Castle Technology Corporation, Massachussets, USA, visited the laboratory under CSIR-NSF Exchange Programme between 4th and 6th January, 1983. He delivered three lectures and held discussions on the latest trends in aluminium extraction, and reviewed the major efforts all over the world to reduce the energy intensiveness of aluminium extraction process. He has initiated steps to take up a collaborative research project with RRL, Bhopal, under the NSF International Programme on Aluminium Extractive Metallurgy.

Dr. G. Komolossy, Geologist, ALUTERV-FKI Hungary, visited the laboratory from 28th January, 1983 to 12th February, 1983 (15 days) under the Indo-Hungarian Exchange Programme of Co-operation in science and technology for the year 1982-1984, and under item 10 "Aluminium Industrial Research". During his stay he gave an exhaustive description of Karstic and laterite bauxites in a series of talks and held discussions on the geology, minerology and chemistry of bauxites. He also gave detailed information regarding the prospection and genesis of bauxites, calculation of mineral reserves and their economic assessment specially using computer programming. He discussed potential R&D activities on beneficiation of low grade bauxites and utilization of lithomarge clay and zeolites, etc. He has expressed interest in collaborative research programmes on Aluminium between ALUTERV Hungary and RRL, Bhopal.

Dr. Andre Masson, Director General, Societe des electrodes et refractories Pechiney Ugine Kuhlmana, Paris, accompanied by Mr. Jhunjhunwala, Chairman, Hindustan Electrographite, Bhopal, visited the laboratory. He expressed a great deal of interest in the project on graphite dispersed aluminium and recognised it as a major outlet for graphite in view of the growing transportation industry in India. Mr. Jhunjhunwala was also keen that RRL, Bhopal, takes up research in fundamental and applied aspects of graphite.

Dr. Bassus an environmental expert from German Democratic Republic, a guest of Department of Bio-Sciences, Bhopal University visited the laboratory and held discussions on the project on natural fibres and on technology assessment with environmental dimensions.

Dr. (Mrs.) Marie T. Dimond, Professor Emerita of Biology, Trinity College, Washington D.C., visited the laboratory. During her visit she discussed her work on fresh water turtles, Bio-ethics and natural resources.

VISITING SCIENTISTS AT THE LABORATORY

Dr. Kanungo, Ex-Assistant Director of National Geophysical Research Institute, H was with the laboratory for a fortnight during which he worked on problems r mineral resources of M.P.

Dr. Bhaskar Majumdar, Assistant Professor, University of Rochester, N.Y., presently on a visit to the laboratory. He delivered a series of lectures on def behaviour of materials with a special emphasis on fundamental and experiment of aluminium alloys.

PROFESSIONAL SOCIETIES BASED IN THE LABORATORY

Efforts have been initiated to start the activities of learned professional societies t a common forum for the professionals in and around M.P. to meet and excha and views. A beginning has been made in this direction with the opening of a c the Institute of Indian Foundrymen at Bhopal with active participation from and R&D organizations in M.P. and RRL, Bhopal. Attempts are underway to oper of Indian Institute of Metals and Indian Institute of Ceramics.

TESTING AND CONSULTANCY SERVICES

A keen interest has been shown by the several public and private sector industries, a large number of metallurgical industries, to avail the capability and the know-h laboratory. A suggested modification in degassing practice in an aluminium ro resulted in lower rejection caused due to gas bubbles. Another private sector al producer has contacted the laboratory for diagnosis of defects in certain alumin ducts. The laboratory is getting equipped to provide consultancy and evaluation in Materials (Fig. 23).

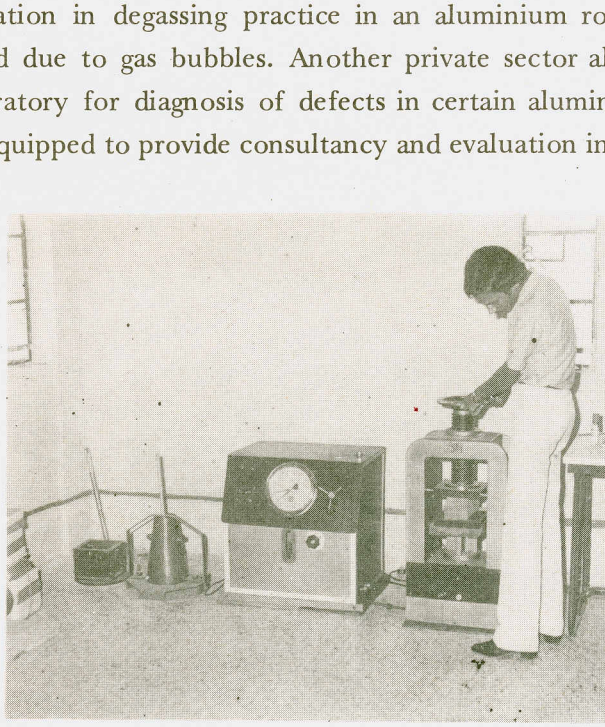


Fig. 23 : Facilities for testing and evalua building materials are being set up Laboratory.

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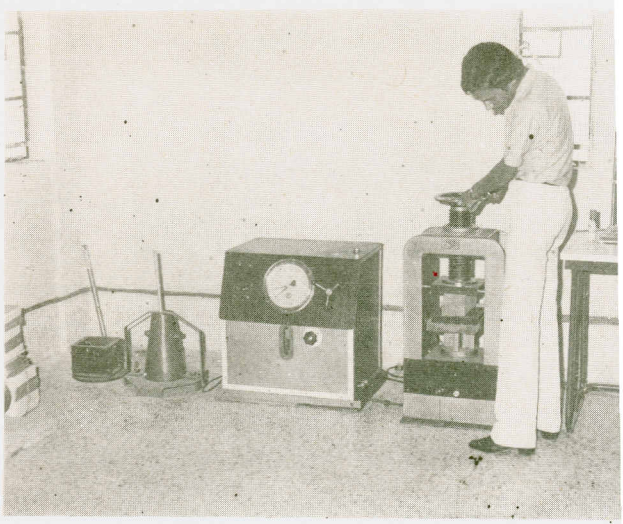

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INFORMATION AT A GLANCE

TECHNICAL PAPERS PUBLISHED BY THE STAFF OF RRL, BHOPAL DURING MAY 1981 TO MAY 1983

1. Deonath and P.K. Rohatgi - Preparation of cast aluminium alloy mica particle composites using copper coated mica particles - J. Mat. Sci. UK, 1981.
2. B.P. Krishnan, M.K. Surappa and P.K. Rohatgi - The UPAL process - A direct method to prepare cast Al-alloy ceramic particulate composites - J. Mat. Sci. UK, 1981.
3. C.K.S. Pillai and P.K. Rohatgi - Cause of deterioration of thatch and its prevention - J. Sci. & Ind. Research, India, 1981.
4. M.K. Surappa and P.K. Rohatgi - Fluidity of Al-Si-Alumina composites - Met. Trans. USA, (6) 1981, P-327-332.
5. K. Gopakumar, C. Pavithran and P.K. Rohatgi - Recovery of tartrate from electroless copper - J. Plating & Surface finishing, USA, Jly. 1981 pp 71-75.
6. D. Suresh, P.K. Rohatgi and J.P. Coutures - Use of solare furnaces in materials research - J. Solar Energy, USA, 26(5) 1981, P-377-391.
7. Deonath, Ram Narayan and P.K. Rohatgi - Damping capacity, machinability and physical properties of Cast Al-alloy mica particle composites - J. Mat. Sci. UK, 16(11) 1981, p-3025-3032.
8. M.R. Madhava, S. Raman, P.K. Rohatgi and M.K. Surappa - Influence of certain microstructural parameters on the ultrasonic velocities and elastic constants of aluminium alumina particulate composites - Scripta Met. USA, 1981 p-1191-1195.
9. B.P. Krishnan, P.K. Narayana Swamy and P.K. Rohatgi - Mechanism of improvement in oil spreadability of aluminium alloy graphite particle composites - Trib Int, UK, Oct. 1981 P-301-305.
10. Deonath and P.K. Rohatgi - Performance of Mica particles in metals as solid lubricants - Proceedings of International Conference on Optimum resources utilization through Triboterotechnology and maintenance Management, Dec 1981, India, G-8 1-24.
11. A. Banerji, S.V. Prasad, M.K. Surappa and P.K. Rohatgi - Abrasive wear of cast Al-alloy Zircon particulate composites - Proceedings of International Conference on Optimum resources utilization through Triboterotechnology and maintenance Management, Dec. 1981, India, F4 1-26.
12. T.K.Dan, V.P. Sreedharan, M.Patel and P.K. Rohatgi - Mechanism of blackening of tile surface - Ceramic Ind J India, 90 (1030), Dec. 1981, P-11-14.
13. S.K. Seshadri, R.M. Pillai, P.K. Rohatgi - Control of Cupola Emissions in Iron Foundries Part I Analysis of Cupola Emissions - Indian Foundry J, 28 (1) 1981, P-1-3.
14. S.K. Seshadri, R.M. Pillai and P.K. Rohatgi - Control of Cupola Emissions in Iron Foundries Part II Measures to Increase productivity and reduce pollution in Cupola - Indian Foundry J, 28(3) 1981, P-13-25.

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TECHNICAL PAPERS PUBLISHED BY THE STAFF OF RRL, BHOPAL DURING MAY 1981 TO MAY 1983

1. Deonath and P.K. Rohatgi - Preparation of cast aluminium alloy mica particle composites using copper coated mica particles - J. Mat. Sci. UK, 1981.
2. B.P. Krishnan, M.K. Surappa and P.K. Rohatgi - The UPAL process - A direct method to prepare cast Al-alloy ceramic particulate composites - J. Mat. Sci. UK, 1981.
3. C.K.S. Pillai and P.K. Rohatgi - Cause of deterioration of thatch and its prevention - J. Sci. & Ind. Research, India, 1981.
4. M.K. Surappa and P.K. Rohatgi - Fluidity of Al-Si-Alumina composites - Met. Trans. USA, (6) 1981, P-327-332.
5. K. Gopakumar, C. Pavithran and P.K. Rohatgi - Recovery of tartrate from electroless copper - J. Plating & Surface finishing, USA, Jly. 1981 pp 71-75.
6. D. Suresh, P.K. Rohatgi and J.P. Coutures - Use of solare furnaces in materials research - J. Solar Energy, USA, 26(5) 1981, P-377-391.
7. Deonath, Ram Narayan and P.K. Rohatgi - Damping capacity, machinability and physical properties of Cast Al-alloy mica particle composites - J. Mat. Sci. UK, 16(11) 1981, p-3025-3032.
8. M.R. Madhava, S. Raman, P.K. Rohatgi and M.K. Surappa - Influence of certain microstructural parameters on the ultrasonic velocities and elastic constants of aluminium alumina particulate composites - Scripta Met. USA, 1981 p-1191-1195.
9. B.P. Krishnan, P.K. Narayana Swamy and P.K. Rohatgi - Mechanism of improvement in oil spreadability of aluminium alloy graphite particle composites - Trib Int, UK, Oct. 1981 P-301-305.
10. Deonath and P.K. Rohatgi - Performance of Mica particles in metals as solid lubricants - Proceedings of International Conference on Optimum resources utilization through Triboterotechnology and maintenance Management, Dec 1981, India, G-8 1-24.
11. A. Banerji, S.V. Prasad, M.K. Surappa and P.K. Rohatgi - Abrasive wear of cast Al-alloy Zircon particulate composites - Proceedings of International Conference on Optimum resources utilization through Triboterotechnology and maintenance Management, Dec. 1981, India, F4 1-26.
12. T.K.Dan, V.P. Sreedharan, M.Patel and P.K. Rohatgi - Mechanism of blackening of tile surface - Ceramic Ind J India, 90 (1030), Dec. 1981, P-11-14.
13. S.K. Seshadri, R.M. Pillai, P.K. Rohatgi - Control of Cupola Emissions in Iron Foundries Part I Analysis of Cupola Emissions - Indian Foundry J, 28 (1) 1981, P-1-3.
14. S.K. Seshadri, R.M. Pillai and P.K. Rohatgi - Control of Cupola Emissions in Iron Foundries Part II Measures to Increase productivity and reduce pollution in Cupola - Indian Foundry J, 28(3) 1981, P-13-25.

15. S.K. Seshadri, R.M. Pillai and P.K. Rohatgi - Control of Cupola Emissions in Iron Foundries Part III Alternatives to Coke and Cupola - Indian Foundry J, 28(4) 1981,P-50-53.

16. M. Patel, T.K. Dan and P.K. Rohatgi - Technological Forecasting for clay and clay-based industries in India towards the year 2000 A.D. J Sci & Ind Res India, 40(8) 1981,P-475-486.

17. P.K. Rohatgi and H. Kahn - On Technology, Change and Future of Asia - Asia 2000 Singapore (I), 1981, P-28-36.

18. R.N. Bhargava and P.K. Rohatgi - Industrial Research and Development in India Co-operation between Public and Private Sector - Proc Seminar Research for Industrial Develop of Kenya, Nairobi - 1981 P-1-25.

19. S. Raman, C.B. Tipnis - Ultrasonic velocity studies of hydrogen bonds, Current Sci. India, 50, 1981 P-8081.

20. Navin Chand - Determination of styrene maleic anhydride copolymer composition by ESCA, Pop. Plastics 3, 1981.

21. P.K. Rohatgi, M.R. Madhava and M.K. Surappa - Potential new solidification experiments in space environments - Bull Mat Sci, India (3) 1982, 283-288.

22. P.K. Rohatgi, M.K. Surappa and M.R. Madhava - Potential new experiments on fabrication of cast particulate composites in space - Bull Mat Sci, India, 4(3), 1982.

23. M.K. Surappa, S.V. Prasad and P.K. Rohatgi - Wear and Abrasion characteristics of Cast Al-Alumina particles composites - Wear, UK, 77, 1982,P-295-302.

24. K.G. Satyanarayana, C.K.S. Pillai, K. Sukumaran, S.G.K. Pillai, Kalyani Vijayan and P.K. Rohatgi - Structure property studies of fibres from various parts of the coconut tree - J Mat Sci, UK, 17(8) 1982, P-2453-2460.

25. B.N. Keshavaram, A. Banerji, M.K. Surappa and P.K. Rohatgi - Cast Aluminium-glass composites J Mat Sci, UK letters 1(1) 1982 P-29-31.

26. R.M. Pillai, S.K. Seshadri, K. Sekhar and P.K. Rohatgi - Coconut shell based fuels for low melting metals and alloys - J Appr Tech, UK, 8(4) 1982, P-28-30.

27. T.P. Murali, S.V. Prasad, M.K. Surappa, P.K. Rohatgi, K. Gopinath - Friction and wear behaviour of Al-alloy-coconut shell char particulate composites - Wear, 80,UK,1981, P-149-152.

28. K. Gopakumar, T.P. Murali and P.K. Rohatgi - Metal-shell char particulate composites using copper coated particles - J Mat Sci, UK, 17(4) 1982, P-1041-1048.

29. Srinivas. D. Sastry, P.K. Rohatgi, K.P. Abraham and Y.V.R.K. Prasad - Influence of heat treatment on the strength and fracture behaviour of Fe-12 Cr-6 A1-Ferritic stainless steel - J Mat Sci, UK, 17(10) 1982,P-3009-3016.

30. C.K.S. Pillai, M.A. Venkataswamy, K.G. Satyanarayana, V.P.Sreedharan and P.K. Rohatgi - A mechanical study of deterioration of coconut leaf thatch under natural and accelerated environmental conditions - J Mat Sci, UK, 17(10) 1982, P-2861-2868.

31. M.S.P. Murthy and P.K. Rohatgi - Estimation of interdendritic undercooling during freezing of ternary and quarternary aluminium alloys - J Mat Sci, UK, 17(8) 1982, P-2194-2198.

32. R.V.G. Menon, G. Inayatullah and P.K. Rohatgi - Solar furnace using secondary concentrator - Proceedings of Solar Energy of Society of India organised by IIT, New Delhi, Dec 1982, P-3-4.

33. P.N. Mohandas, V.S. Kelukutty, K. Gopakumar and P.K. Rohatgi - Reduction of iron ore and mill scale using coconut pith and coconut shell as reductants - Trans IIM, India, Feb 1983.

34 P. Sastri, G.N.K. Iyengar and P.K. Rohatgi - Energy analysis of aluminium extraction in India P.I. Energy conservation patterns - Trans IIM India, 35(6), 1982, P-552-557.

35. P. Sastri, G.N.K. Iyengar and P.K. Rohatgi - P.II- Alternate routes to aluminium extraction Trans IIM, India, 35(6) 1982,P-558-563.

36. P. Sastri, G.N.K. Iyengar and P.K. Rohatgi - P-III-Importance of recycling of aluminium in India, Trans IIM, 35(6) 1982,P-564-567.

37. A. Banerji and P.K. Rohatgi - Cast aluminium alloy containing dispersions of titania and zirconia particles - J Mat Sci, UK, 17(2) 1982, P-335-342.

38. D. Suresh and P.K. Rohatgi - Use of solar furnace-II Thermophysical properties - J Solar Energy,UK 28(4), 1982,P-273-280.

39. A.Banerji, S.V. Prasad, M.K. Surappa and P.K. Rohatgi - Abrasive wear of cast Al-alloy Zircon particle composites - Wear,UK,May 1982, P-141-151.

40. S.Mohan, S. Suresh Kumar, P.D. Ekbote, Ramnarayan, H. Sreemulanathan and P.K. Rohatgi-Technological Forecasting for Homogenous Geographical Regions, Kerala State - J Sci and Ind Res, India, 41(3) 1982,P-163-174.

41. P.K. Rohatgi, B. Nagraj and K. Rohatgi - Future Technologies for Metals and Materials in India - J Sci and Ind Res, India, 41(6) 1982, P-351-360.

42. K.G. Satyanarayana, S. Mohan, P.N. Mohandas, A.G. Mathew, H. Sreemulanathan and P.K. Rohatgi Plantation products Industry as a resource for Materials - J Sci and Ind Res, India, 41(2),1982 P-83-87.

43. S.P. Gujral and P.K. Rohatgi - Brain Drain and Utilization of Expatriate Expertise through in India - Proceeding of UNDP-TOKTEN Conference, Islamabad, 1982, P-1-8.

44. P.K. Rohatgi and K. Rohatgi - Methodologies of Technological forecasting and their application to long term educational planning - Proc UNESCO-ESCAP Regional Workshop in long term educational planning New Delhi Jan 1982.

45. T.K. Dan, C.V. Gokularathnam and P.K. Rohatgi Research and Development and Technological Imperatives for Glass in India towards the year 2000, J Sci and Ind Res, India, 1982.

46. T.K. Dan and P.K. Rohatgi - Scientific and Technological Imperatives in Laterites towards the year 2000 A.D. - J Sci and Ind Res, India, 41(1) 1982, P-1-7.

47. T.K. Dan, C.V. Gokularathnam and P.K. Rohatgi-Silica Minerals A Resource in Future India - J Sci and Ind Res, 41(8), India 1982, P-469-481.

48. L.P.Rai, A. Ghosal, P.Shaha and S. Kumar - Recent Developments in optical fibre communication system and its future in India J Sci and Ind Res India 41(9) 1982.

49. V. Shiv Kumar, Ram Narayan and Y.C. HSU - Interaction between an elastic circular hole and two symmetrically placed co-linear line cracks - 19th Annual Meeting Society of Engineering Science, Oct 27-29, 1982, Missouri, USA.

50. B.N. Keshavaram, K.G. Stayanarayana, P.K. Rohatgi-Extrusion properties of Al-glass and Al-Flyash particulate composites Proce Int Conf on Ceramic held at Bangalore India on 29th Nov. 1982.

51. A.H. Yegneswaran, K.S. Raman, Y.V.R.K. Prasad - Texture strengthening in warm rolled Cd - 1% Ag alloy, phil Mag A, 46-3, 1982 pp 507-519.

52. K. Tangri, A.H. Yegneswaran, Strength/dectility microstructure relationships in two phase materials Proc VI ICSMA ed R.C. Gritkins, Melbourne, Australia Pergamon Press Aug 1982 pp 373-378.

53. S.Raman, C.B. Tipnis - Ultrasonic studies in camphene solutions, Ind. J Pure & App. Phys India, 20, 1982,P-79-80.

54. S. Raman, Ultrasonic velocity studies of phase transition of solute while in solution, Acustica, W. Germany, 52(1) 1982.

55. Navin Chand - Studies in surface anisotropy of PET fibres by ESCA and SEM. Pop. Plastics, 1982.

56. Navin Chand - D.C. conductivity study of $BaCl_2$ adoped PVC A new T_g d.c. conductivity relation, India J. of Phy. 15A 183, 1982.

57. Navin Chand - Electrical Prop. of polymer salt mixture Pop. Plastics Jan 3,8,1982.

58. Navin Chand - Free volume and ionic d.c. conductivity in polymers, J.App. Poly. Sci. 27, 1982.

59. L.G. Shpinova, I.N. Yashchishin and B.R. Chamarthy - Investigation of Microstructure and properties of clinker based glasses and their crystallisation PRODUCTS, Central Glass and Ceramic Research Institute Bulletin, Vol. 29, No.1, 1982.

60. Navin Chand - Surface studies of acid treated PET fibres, Colloids and Surfaces 4, 1983, 1982.

61. Navin Chand - Surface studies of amine treated PET filament-India J Tex Res vol.8 March 1983 P-23-24.

62. Navin Chand - A new relationship of D.C. conductivity with loss modulus in PET Mat - Sc letters 2, 1983, pp 83-84.

REPORTS PREPARED BY THE STAFF OF RRL, BHOPAL

1. Natural Fibres in Madhya Pradesh as a Resource for Industrial Materials.
2. Techno-economic Forecasting of M.P. towards the year 2000 A.D.
3. Physical and mechanical properties of particulate composites.
4. Fracture behaviour of particulate filled systems.
5. Energetics of transfer of spherical particles from gas phase to liquid phase.
6. Properties of Iron Powder and Iron Oxide fume polyester composites.
7. Use of Ultrasonic energy in dispersing solid particles in liquid metals.
8. Ultrasonic velocities in aluminium-zircon composites.
9. Preparation of aluminium-talc composites.
10. Mineral resources of Madhya Pradesh and the prospects of mineral based industries in the State.
11. Development of natural fibre polyester composites.
12. Research and Development opportunities related to Bauxite.

PAPERS PRESENTED IN SEMINAR/SYMPOSIUM/WORKSHOP/CONFERENCES BY THE STAFF OF RRL, BHOPAL

1. Composite dental filling materials - S.V. Prasad, C. Pavithran and P.K. Rohatgi at 36th Indian Dental Conference, New Delhi Dec 1981.

2. Introduction of solid particles in liquid metals for energy conservation in metallurgy - P.K. Rohatgi at Indo-US Workshop on Research Needs in Mineral Processing and Chemical Metallurgy Dec. 1981.

3. Performance of mica particles in metals as solid lubricants - Deo Nath and P.K. Rohatgi at TRIBO-MAINT '81 International Conference, IIT, Delhi Dec 1981.
4. Methodologies of technological forecasting and their application to long-term educational planning - P.K. Rohatgi at Regional Workshop on Long-term Educational Planning, New Delhi Jan 1982.
5. Abrasive wear of cast aluminium alloy-zircon particle composites - A. Banerji, S.V. Prasad, M.K. Surappa and P.K. Rohatgi at Aluminium Congress India, New Delhi, Feb 1982.
6. Research and production imperatives in Aluminium towards the year 2000 A.D. - P.K. Rohatgi, K.G. Satyanarayana, J. Cheriyan, B. Nagaraj, P. Shastri and S. Seshan at Aluminium Congress India, New Delhi Feb 1982.
7. Ultrasonic velocity and attenuation in coir-polyester composites - M.R. Madhava, S. Raman, C. Pavithran, S.V. Prasad and P.K. Rohatgi at Second National Symposium on Ultrasonics, New Delhi - Feb 1982.

SEMINAR/SYMPOSIUM/WORKSHOP/CONFERENCES ATTENDED BY LABORATORY STAFF

1. Dr. P.K. Rohatgi attended the UNCTAD/SIDA Workshop on 'Technology Policies and Planning for Technological Transformation', Bangalore, June 1981.
2. Dr. P.K. Rohatgi attended the seminar on 'Science Technology and Social Development in India', University of Kanpur, October 1981.
3. Dr.P.K. Rohatgi, Dr. Ram Narayan and Mr. P.D. Ekbote attended the Seminar on 'Growth prospects of aluminium in 80's', New Delhi, Nov. 1981.
4. Dr. P.K. Rohatgi attended the 'International Workshop on the Physics of Semiconductor Devices', Solid State Physics Laboratory, New Delhi, Nov 1981.
5. Dr. P.K. Rohatgi attended the seminar on 'Materials for advanced Energy Systems', IIT,Kanpur,Dec 1981.
6. Dr. P.K. Rohatgi attended the Workshop on 'Business and Training opportunity in Technology and Technology Transfer, TFAI, New Delhi,Dec. 1981.
7. Dr. P.K. Rohatgi attended the 'TRIBO-MAINT' 81 International Conference on Optimum Resources Utilization through Tribo Terotechnology and Maintenance Management, IIT, Delhi, Dec. 1981.
8. Dr. P.K. Rohatgi attended the 36th Indian Dental Conference, New Delhi, Dec. 1981.
9. Dr. Ram Narayan attended the XVII Annual Convention of Computer Society of India, Madras, Jan. 1982.
10. Dr(Mrs.) Sudha Raman attended the Solar Energy Convention, IISc. Bangalore Jan. 1982.
11. Dr. P.K. Rohatgi attended the Conference on long term educational planning, NIEPA, New Delhi, Jan. 1982.
12. Dr. P.K. Rohatgi, Dr. Ram Narayan, Mr. P.D. Ekbote, Dr.(Mrs.) Sudha Raman and Dr. L.P. Rai attended the Aluminium Congress India, New Delhi, Feb. 1982.
13. Dr. P.K. Rohatgi attened the Second National Symposium on Ultrasonics, NPL, New Delhi, Feb. 1982.
14. Dr. P.K. Rohatgi attended the National Seminar on 'Building Materials - Their Science and Technology', New Delhi, April 1982.
15. Dr. P.K. Rohatgi attended the National Solar Energy Convention of the Solar Energy Society of India, at IIT, Delhi, December 17-19, 1982.
16. Dr. T.K. Dan attended the Annual Conference of Indian Ceramics Society at Morvi 25-28 April, 1982.

17. Dr. T.K. Dan, Shri P.D. Ekbote and Shri M. Subhash attended the Seminar on 'Small Scale Aluminium Industries' conducted by the S.I.S.I., Indore, Sept. 13, 1982.
18. Dr. P.K. Rohatgi, Shri P.D. Ekbote and Dr. T.K. Dan attended the seminar on 'R & D for planned utilization of mineral Resources' conducted by INSA. New Delhi, Oct. 1982.
19. Dr. P.K. Rohatgi, Shri A.C. Khazanchi, Dr. T.K. Dan, Dr.(Mrs.) Sudha Raman, Dr. A.M. Popli, Shri M. Subhash, Miss V.L. Keshwani attended the 8th BHEL Inter Unit Foundry Meet at BHEL Bhopal, Sept. 1982.
20. Dr.(Miss) Mohini Saxena attended the 'International symposium on Recent Aspects of Electro-analytical chemistry and Electro Chemical Technology' organized by the Department of Chemical Engineering & Technology, Punjab University, Chandigarh - 28th to 30th Dec. 1982.
21. Prof. P.K. Rohatgi, Shri A.C. Khazanchi, Dr.T.K. Dan, Dr. Ram Narayan, Shri P.D. Ekbote, Dr.(Mrs.) Sudha Raman, Dr.(Miss) Mohini Saxena, Dr. C.B. Raju, Miss Sandhya Sood, Shri A.K. Jha, Shri M. Subhash, Shri A.V. Ramana Rao and Shri P.K. Verma attended a seminar on modern trends in foundry technology at BHEl on 5th March 1983.
22. Dr. C.B. Raju attended the silver jubilee workshop on "Research Needs in Mineral Processing and Chemical Metallurgy" organised by the Department of Metallurgical Engineering, Indian Institute of Technology, Bombay, from 15-16 March, 1983.
23. Shri A.K. Jha attended the PMAI annual meeting at Goa on April 9th 1983.
24. Dr. A.H. Yegneswaran and Shri K.K.S. Gautam attended a two day conference on modern agricultural machinery at Bhopal.
25. Prof. P.K. Rohatgi, Shri A.C. Khazanchi, Dr. Navin Chand attended a symposium on potential of medicinal and aromatic plant based drugs conducted by M.P. Council of Science & Technology and the CSIR PTC, Bhopal.

PROBLEMS POSED BY DIFFERENT INDUSTRIES IN MADHYA PRADESH TO RRL, BHOPAL

Within a short span of two years, the laboratory has been contacted for advice and expert opinion by several small, medium and large industries in the region. These are metallurgical, plastic, chemical industries. Some of the typical problems posed are mentioned below:-

1. Lower mechanical properties of sand cast and chill cast LM 6 alloy test bar. Risering of steel casting for improvement of yield and freedom from defects. Sand fusion in steel casting riser necks.
2. Casting defects.
3. Losses in castings.
4. Bubbles and chips in Brass circles.
5. Defects in castings, shaping problems.
6. Defects in rolling and casting.
7. Rolling and shearing problems.
8. Casting of Piston.
9. Sand binders for casting.
10. Chemical analysis of nonferrous castings. Ultrasonic and Radiographic Testing of castings.
11. Techniques for stamping of utensils.
12. Availability of high grade limestone and dolomite for L.D. Converter.
13. Chemical analysis, Raw Materials, New Products.

LECTURES AT RRL, BHOPAL

(A) *LECTURES DELIVERED BY OUTSIDE EXPERTS AT R.R.L., BHOPAL*

Lecture delivered by	Subject
Mrs. Bandhopadhyay Deptt. of Physics M.A.C.T., Bhopal.	Electrets.
Mr. V.N. Vashist Council of Scientific & Industrial Research	Formation of Science and Technology Plan in India.
Mr. H.S. Yadava Deptt. of Regional Planning & Economic Growth, Bhopal University, Bhopal.	a) Techniques in Social Research . b) Statistics as applied to forecasting.
Mr. Satyendra Narayan	a) Introduction of Quantitative Techniques - applied to Geophysical problems. b) Introduction to Geophysical problems. c) Recent techniques of oil exploration.
Pramod Kumar Singh St. John's College, Agra.	Technological gap in India: Reference to Rural Development
Dr. K.G. Satyanarayana, Head, Materials Division, RRL, Trivandrum.	a) Studies on Natural Fibres. b) Composites based on natural fibres.
Dr. B.P. Krishnan ESCORTS, Bangalore.	Tribological properties of Al-graphite Pistons.
Dr. Pathak, IIP Dehradun.	Modern Surface Analytical Tools in Tribology.
Dr. Ramesh Sharma, Senior Engineering Manager, Microprocessor Dn., Fairchild Camera and Instrument Corpn. New York.	a) OSPREY TECHNOLOGY for producing metal powders. b) Wear of Hot forging dies during the first five blows .
Dr. Jaiswal CSIO, Chandigarh.	Interferometric methods for temperature measurement.
Dr. Paul Pemsler Castle Technology Corporation, Boston, USA.	a) Metallurgy of ocean Nodules. b) Extraction of Aluminium by Electrolysis. c) New Processes for recovering Aluminium from its ores.
Dr. T. Satyanarayana School of Bio-Sciences, Bhopal University, Bhopal.	Microbes in Hydro-metallurgy.
Dr. Bhaskar S. Majumdar University of Rochester, New York, USA.	Crack tip shielding Phenomena.

Mr. V.K. Agarwal HINDALCO, Renukoot UP.	Research & Development Imperatives in Aluminium Industries in India.
Dr. J.P. Sharma ITMMEC, IIT, Delhi.	Friction and Tribology.
Dr. V.R.R. Uppuluri Oak Ridge Institute, Tennessee, USA.	Mathematical and Statistical problems in risk analysis
Dr. A.M. Popli SAIL, Ranchi.	Internal friction due to dislocations.
Mr. B.M. Shukla IIP, Dehradun.	Laboratory evaluation of rolling oils for steels.
Dr. P. Gandhi RRL, Trivandrum.	Future development of forest products.
Mr. S. Das IIT, Kanpur.	Crystallization behaviour of rapidly solidified Iron-Boron alloys.
Mr. B.N. Keshavaram RRL, Trivandrum.	Aluminium-glass composites.
Dr. R.K. Pandey IIT, Delhi.	Fracture mechanics of composite materials.
Dr. A. Mubeen MACT, Bhopal.	Fracture mechanics.
Dr. G.S. Upadhyaya IIT, Kanpur.	Advances in powder metallurgy
Dr. G. Komolossy Geologist, Budapest, Hungary	a) Comparison of laterite and Karstic Bauxite. b) Genetics, Geology and mining of Bauxite. c) Calculation of mineral reserves and economic evaluation.
Dr. D.N. Kanungo Ex-Asstt. Director NGRI, Hyderabad	Some problems of exploration of non-renewable mineral resources.
Dr. M.M. Nandi Calcutta University Deptt. of Chemistry Agartala	Use of microbial energy in mineral processing.
Dr. S. Mohan RRL, Trivandrum.	Research priorities in development
Dr. B.S. Majumdar	Deformation and fracture in metals and ceramics - A mini course comprisinga set of 12 lectues.
Mr. B. Damodaran RRL, Trivandrum.	Secretarial practices in modern management.
Dr. D.C. Gupta J.K. Sythetics, Kota.	Blending of polyesterene with styrene siloxane.

Dr. Marie T Dimond Trinity College Washington D.C.	Bio-ethics and natural resources.

(B) *LECTURES DELIVERED BY STAFF OF RRL, BHOPAL AT RRL, BHOPAL.*

Mr. P.D. Ekbote	Introduction to Technological forecasting. A forecasting study of M.P. towards the year 2000 A.D. Agitation systems for metal particulate suspensions.
Mr. Amol Kumar Jha	Sintering of Aluminium based composites.
Mr. M. Subhash	Shape forming of composites.
Mr. P.K. Ghosh	Preparation of composites by compocasting method. Bonding and chemical compatibility.
Dr. P.K. Rohatgi	Cast Metal Ceramic composites; Technological Forecasting.

(C) *LECTURES DELIVERED BY THE STAFF OF RRL, BHOPAL IN OTHER ORGANIZATIONS*

Lecture delivered by/ Name of organization	**Subject**
Dr. P.K. Rohatgi	
IIT, Delhi	Techniques of Technological Forecasting to select opportunities in supply of rural energy.
Korean Advanced Institute of Science & Technology, Seoul	Cast-Aluminium Ceramics Particle Composites for anti-abrasion and antifriction applications.
IIT, Kanpur	Preparation and mechanical processing of Fe-12 Cr-9A1 Ferrite stainless steel.
Centre of Asian Studies, Hong Kong University	Technology forecasting and appropriate technology.
Convention of Indian Employers, New Delhi	Implications of new technologies on employers and employees in Indian Industries towards 2000 A.D.
University of Roorkee	Composites.
IIM, Kanpur Chapter	Aluminium in the Future of India.
British Aluminium Research Laboratories, U.K.	Cast aluminium base composites.
Research Centre, ALUTERV, Budapest, Hungary	Solidification of aluminium to make cast composites.
National Bureau of Standards, Washington D.C., USA.	Preparations and tribological properties of cast aluminium-ceramic particle composites.
Institution of Engineers, Kanpur Chapter	Solar furnaces.

CSIR Polytechnology Transfer Centre and M.P. Council of Science and Technology.	Futuristics trends in development of Science and Technology.
BHEL, Bhopal Chapter Institute of Indian Foundrymen	Modern Trends in Foundry Technology.
DGTD, New Delhi	Technology Forecasting.

(D) RADIO TALKS

Prof. P.K. Rohatgi gave a talk on the "Role and Expansion of CSIR in M.P." on All India Radio, Bhopal, in February, 1983.

TRAINING PROGRAMMES ATTENDED BY RRL STAFF

Dr.(Mrs) Sudha Raman	a) Entrepreneurship course on glass fibre reinforced plastics, Dec 14-19, 1981, Bhopal. b) International School on synthesis, crystal growth and characterization of materials for energy conversion and storage, October 12-23, 1981 New Delhi. c) A refresher training course in practical electronics at BHEL, Bhopal, Jan 22 to Feb 6, 1983.
Mr. P.D. Ekbote	A short term course on 'Mathematical modelling of metallurgical and mineral processes' at department of Metallurgical Engineering, IIT, Kanpur, Dec 1-15, 1982.

TRAINING OFFERED BY RRL

The RAC and EC of RRL, Bhopal, has approved RRL, Bhopal, for giving training in the areas of Materials, Energy and Forecasting.

1. Mr. P.S.S. Bisen was given training in the area of chemical analyses of ores, minerals, metals, etc.
2. Mr. H.N. Parmar was given training in polymer based composites.
3. Mr. R.K. Nema was given training in mineral resource characterization.

HONOURS AND AWARDS RECEIVED BY STAFF

1. Prof. P.K. Rohatgi received the Technologies of the Future Award, instituted by Indian Seminar and Research Centre, Hyderabad, for the year 1981 for his outstanding contributions to Technological forecasting.
2. Prof. P.K. Rohatgi received the Distinguished Aluminus Award for the year 1983 from the Department of Metallurgy, Banaras Hindu University for his outstanding contributions to Metallurgy.

3. Prof. P.K. Rohatgi was elected as a Fellow of the Institution of Engineers, India.

4. Mr. A.C. Khazanchi was a member of the project team which won the Institutional Award for the year 1982 from FICCI for low cost roofing sheet from cellulosic material to the RRL, Jorhat.

MEMBERSHIP OF COMMITTEES/SCIENTIFIC SOCIETIES IN INDIA OR ABROAD

1. *Dr. P.K. Rohatgi*

   i) Fellow, The Institution of Engineers (India)
   ii) Fellow, Institute of Ceramics (India)
   iii) Life Member, Indian Institute of Metals
   iv) Member, Board of the International Editors, International Cast Metals Journal American Foundry Society, USA.
   v) Member, Board of International Editors, Technology Forecasting and Social Change, International Journal, USA.
   vi) Member, Editorial Board of Indian Foundry Journal.
   vii) Member, International Advisory Board of the Journal of Indian Council for Management and Future.
   viii) Member, Editorial Board, ASIA 2000.
   ix) Member, Editorial Advisory Board, Current Literature, Science of Science, CSIR.
   x) Member, Solidification Committee, American Institute of Mining and Metallurgical Engineers, USA.
   xi) Director, M.P. Urja Vikas Nigam Limited, Bhopal.
   xii) Member, National Steering Committee on Composite Materials.
   xiii) Member, Advisory Committee on Centre of Energy Studies, IIT, Delhi.
   xiv) Member, Advisory Committee on ITMMEC, IIT, Delhi.
   xv) Member, American Society of Metals.
   xvi) Co-opted member of the Acadmic Council of the Bhopal University.
   xvii) Member on the Board of Studies in Physics under the Faculty of Science, Jabalpur University.
   xviii) Member of the Metals and Materials Committee of CSIR.
   xix) Member, Institute of Indian Foundrymen.
   xx) Honorary visiting Professor, Indian Institute of Technology, Hauz Khas, New Delhi.

2. *Dr. Ram Narayan*

   i) Member, Computer Society of India
   ii) Member, Institute of Indian Foundrymen.

3. *Mr. P.D. Ekbote*

   i) Member, Indian Institute of Metals.
   ii) Member, Institute of Indian Foundrymen.

4. *Dr. (Mrs.) Sudha Raman*

   i) Associate Member, NDT Society of India & Ultrasonic Society of India.

Dr. L.P. Rai

i) Member Society of Management Science & Applied Cybernetics.
ii) Asstt. Editor, SCIMA, Journal of Management Science & Applied Cybernetics.

6. *Dr. T.K. Dan*

i) Member, Indian Ceramic Society.
ii) Member, Institute of Indian Foundrymen.

7. *Mr. A.K. Jha*

i) Member, Powder Metallurgist Association of India.

8. *Miss Vijaylaxmi Keshwani*

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9. *Mr. A.V. Ramana Rao*

i) Member, Institute of Indian Foundrymen.

10. *Dr. A.H. Yegneswaran*

i) Member, TMS-AIME

11. *Mr. K.K.S. Gautam*

i) Member, Institute of Electronics and Telecommunication Engineers (IETE).
ii) Member, Indian Physics Association, Bombay Chapter

DISTINGUISHED VISITORS TO THE LABORATORY

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3. Shri Ramchandra Singh Deo, Member, State Planning Board, Madhya Pradesh
4. Shri N.R. Krishnan, Secretary, M.P. Council of Science and Technology, Bhopal.
5. Dr. Ramesh Sharma, Senior Engineering Manager, Microprocessor Division, Fair Child Camera & Instrument Corporation, New York, USA.
6. Dr. Paul Pemsler, President, Castle Technology Corporation, Basten Massachusetts, USA.
7. Dr. G. Komolossy, Geologist, ALUTERV-FKI, Budapest, Hungary.
8. Shri V.K. Agarwal, Chief R&D, Hindalco, Renukoot.
9. Dr. N.C. Nigam, Director, Thapar Corporate R&D Centre, Patiala.
10. Shri Andre Masson, Director General, Societe des electrodes et refractaires savoie, Pechiney Ugine Kuhlmann, 15, ure du rocher utppi, Paris.
11. Prof. W. Bassus, Sektion Forstwirtschaft, DDR-8223 Pienner Strasse-8, Tharndt; G.D.R.
12. Dr. (Mrs.) Sushama Mehar, NIEPA, New Delhi.
13. Dr. (Mrs.) Marie T. Dimond, Training CollegeWashington D.C.
14. Shri Iyer and Shri Bhattacharya of the All India Radio, Bhopal.
15. Dr. V.R. Gowarikar, Director, Vikram Sarabhai Space Centre, Trivandrum.
16. Dr. T.S. Murthy, Director, M.P. State Council of Science and Technology, Bhopal.
17. Prof. W.D. West, Emeritus Professor, Department of Applied Geology, Sagar University, Sagar, M.P.

18. Dr. D.K. Srivastav, Head of the Department of Geology, M.V.M. College, Bhopal.
19. Dr. K. Sreenivasulu, Reader, Department of Chemistry, Vikram University, Ujjain, M.P.
20. Dr. S.S. Lal, Superintendent Geologist, M.P. State Ground Water Surveys, Bhopal.
21. Shri K.K. Choudhary, Superintendent Geologist, M.P. State Water Surveys, Bhopal.
22. Shri G.K. Dev Burman, Senior Hydrogeologist, Central Ground Water Board, Bhopal.
23. Dr. R.G. Rastogi, Director, Institute of Geomagnetism, Bombay.
24. Dr. J.K. Maheshwari, Director, National Botanical Research Institute, Lucknow, U.P.

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Bhopal (M.P.)

7. Dr. T.S. Murthy
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Maulana Azad College of Technology
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11. Prof. J.P. Sharma
Head, ITMMEC
IIT, Hauz Khas
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   Bhopal, M.P.

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   Bhopal (M.P.)

3. Dr. Ram Narayan
   Scientist
   Regional Research Lab.
   Bhopal (M.P.)

4. Prof. G.S. Upadhyaya
   Professor of Metallurgy
   IIT Kanpur
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5. Dr. B.B. Ramaiah
   Managing Director
   Andhra Sugar Limited
   Tanuku (A.P.)

6. Mr. N.R. Krishnan
   Secretary
   Deptt. of Science & Technology
   Govt. of Madhya Pradesh
   Bhopal (M.P.)

7. Administrative Officer
   Regional Research Lab.
   Bhopal (M.P.)

8. Finance & Accounts Officer,
   Regional Research Lab.
   Bhopal (M.P.)

Invitee

9. Nominee of DG,SIR

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   Scientist

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2. Dr. Ram Narayan
   Scientist

3. Mr. P.D. Ekbote
   Scientist

4. Mr. O.P. Saini
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1. Dr. T.K. Dan
   Scientist

Member

2. Mr. R.K. Bajaj
   Stores & Purchase Officer

3. Mr. P.D. Ekbote

4. Mr. T.V. Apasthamban
   Finance & Accounts Officer

LIST OF SCIENTIFIC STAFF WORKING IN THE REGIONAL RESEARCH LABORATORY, BHOPAL

S.No.	*Name*	*Designation*	*Field of specialization*
1.	Prof. P.K. Rohatgi	Director	Materials Science and Technology Forecasting, Solar Energy.
2.	Mr. A.C. Khazanchi	Scientist-E-II	Civil Engg., Building Materials Foundation, Cement concrete.
3.	Dr. Ram Narayan	Scientist C	Maths, Fracture, Technology Forecasting, Systems Analysis.
4.	Dr. T.K. Dan	Scientist C	Ceramics, Materials composites.
5.	Dr. A.H. Yegneswaran	Scientist C	Deformation and Texture
6.	Dr. Navin Chand	Scientist B	Polymers, composites, natural fibres.
7.	Mr. K.K.S. Gautam	Scientist B	Electronics, Instrumentation
8.	Mr. P.D. Ekbote	Scientist B	Chem. Engg., Metallurgy, Management
9.	Mr. A.K. Jha	Scientist B	Powder Metallurgy
10.	Mr. A. Banerji (On leave)	S.S.A.	Materials Science, composites.
11.	Mr. J.S. Sharma	J.S.A.	Mineral Engineering
12.	Dr. B.S. Majumdar	Visiting Scientist	Deformation and Fracture
13.	Dr. A.K. Dixit	Visiting Scientist	Mineral Processing
14.	Dr. Ravi Prakash	Consultant	Biological Materials
15.	Mr. S.C. Arya	Consultant	Metallurgy
16.	Mr. M. Subhash	Pool Officer	Metallurgy, Mat. Science
17.	Dr. C.B. Raju	Pool Officer	Ceramics, Materials
18.	Dr. A.M. Popli (Upto 2.11.1982)	Pool Officer	Physical Metallurgy
19.	Mr. P.K. Ghosh	Pool Officer (Placed at University of Roorkee)	Materials, composites
20.	Dr. (Mrs.) S. Raman	Research Associate	Physics, Acoustics, Mat. Science
21.	Dr. (Mrs.) K. Rohatgi	Research Associate (Placed at Bhopal University)	Microbiology
22.	Dr. (Ms) M. Saxena	Research Associate	Electrochem., Corrosion
23.	Dr. L.P. Rai	P.D.F.	Maths, Forecasting, Operational Research
24.	Ms. Sandhya Sood	S.R.F.	Chem., Natural Fibres

25.	Mr. T.V.V.R. Appa Rao	SRF (Placed at IIT, Delhi)	Chem.Engg., Systems Planning
26.	Mr. Abhay Sahai	S.R.F. (Placed at IIT, Delhi)	Physics, Energy
27.	Mr. A.V. Ramana Rao	S.R.F.	Chem. Engg., Tribology
28.	Ms. V.L. Keshwani	J.R.F.	Metallurgy
29.	Mr. P.K. Verma	J.R.F.	Mechanical Engineering
30.	Mr. S. Das	Research Officer	Rapid solidification

ADMINISTRATIVE

1.	Mr. S.P. Kaushika	(7.9.1981 to 30.6.1982)	Administrative Officer
2.	Mr. O.P. Saini	(23.8.1982 to 13.5.1983)	Administrative Officer
3.	Mr. Tariq Qutbuddin	(Since 31.5.1983)	Administrative Officer
4.	Mr. T.V. Apasthamban	(Since 28.1.1982)	Finance & Accounts Officer
5.	Mr. Harihar Nath	(24.2.1982 to 4.2.1983)	Section Officer
6.	Mr. Omman Panicker	(Since 9.2.1983)	SPA to Director
7.	Mr. N.C. Chakravarty	(Since 16.2.1983)	Section Officer
8.	Mr. R.K. Bajaj	(Since 27.2.1982)	Stores & Purchase Officer
9.	Mr. T.P. Prasannan	(Since 3.3.1983)	Senior Stenographer
10.	Mr. M.L. Sharma	(Since 24.5.1982)	Security Assistant
11.	Mr. Pratap Singh	(Since 13.8.1982)	Driver (Staff Car)