RESEARCH INITIATIVES IN EARTH SCIENCES BY DEPARTMENT OF SCIENCE AND TECHNOLOGY

In the process of evolution

In search of better means to serve the Nation

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EARTH SCIENCES PROGRAMME IN DST

Vision and Goals of Earth System Science Division

Achieve better insight into the natural events and processes working on the planet through promotion of basic research.

Guide, inspire and enable the earth scientists to recognize & meet the national aspirations and as well as to fulfill societal demands for better and safe living.

Extension of support for research in emerging and frontline areas of earth system science.

Programme Advisory Committee on Earth Sciences (PAC-ES)

An SERC Programme

Scope : Study of Earth and Earth System Processes – its coupling with the atmosphere & oceans.

- R&D projects are supported
- Co-ordinated programmes are evolved
- Manpower Development through Summer / Winter Schools on specific areas of importance
- State of the Art Facility creation for pursuing frontier areas of earth science research

Major Research Areas

- **Field Mapping –** Structure & Lithology
- **Basin Modelling**
- **Sequence Stratigraphy**
- **Himalayan Geology**
- **Mesozoic Of Kutchch**
- **Chemical Thermodynamics**
- **Geo-hydrology**
- **Vertibrate & Micro Paleontology**

SCIENCE AND ENGINEERING RESEARCH BOARD

- A statutory Body under DST
- Basic Mandate- to promote basic Science Research and support extramural research grants to Individual Scientist.
- Physical Sciences
- Chemical Sciences
- Biological Sciences
- Engineering Sciences
- ***Earth and Atmospheric Sciences***
- ***Total about-18 PACs***

Objectives of SERB

- To promote research in newly emerging and frontline areas of Science and Engineering including multi-disciplinary fields.
- To selectively promote the general research capability in relevant areas of Science & Engineering taking into account existing research capabilities of the host institution.
- To encourage young scientists to take up challenging research and development activities.

Earth Science Research during the last 5 years

Total Projects supported – 143

Different Theme areas

Quaternary Geology- 20

Structure and Tectonics-21

Stratigraphy and Paleontology-25

Palaeoclimate-24

Petrology-23

Hydrogeology-16

Metallogeny-10

Geophysics-4

- Total PhDs (Ongoing/ completed)- about 100
- Publications @ 2 papers per project – 300
- Total amount spent- Rs.3575 lakhs
- National Facilities created under IRPHA program during the last 10 years- 12
- Amount spent-Rs.4814 lakhs
- Manpower trained- 150 (50 PhDs)
- Publications- 400
- Project proposals received 80 projects per year and about 35 projects are supported.

Proposal received from States

- Tamilnadu, West Bengal, Karnatak and Maharastra – more number of proposals
- Chhatisgarh, Madhya Pradesh, Bihar and Odisha- hardly any proposals.

Workshops/ Training programmes organised

- Structure and Deformation
- Tectonic Geomorphology (S/W School)
- Groundwater contamination (Fluoride and Arsenic)
- Isotope Hydrology
- S/W School on Palaeoclimate studies
- Geomathematics
- Basic Geophysical Techniques
- Balanced Cross Section
- Palaeomagnetic studies

Specialised R&D Programmes Initiated:

- **Tectonic Geomorphology**
- **Water Resources**
- **Palaeo Climate**
- **Geoarcheaology**
- **Ground water contamination**
- **Science of Shallow Subsurface**

SSS PROGRAMME

Objectives of DST-SSS Programme

- To obtain accurate description of near surface (~ 100 m) properties and processes, including geological, geophysical, geochemical and geomicrobiological.
- To manage and guide changes in the near surface environment, both naturally and culturally induced, through generation of sound scientific knowledge of this part of the earth.

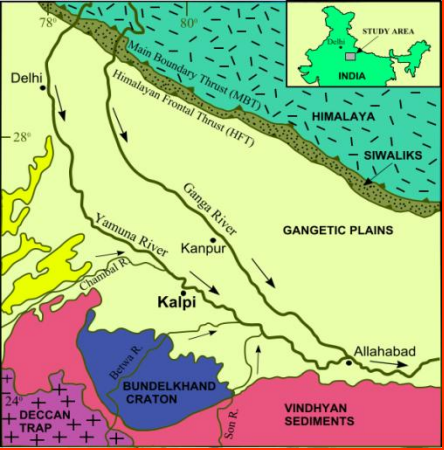
INTEGRATED STUDIES BEING TAKEN UP

- **Geological features and properties** – Lithology, densities; distribution of fractures, faults, lithological contacts, bedding planes and their geometry, depth to water table.
- **Physical properties** – porosity, permeability, hydraulic conductivity, electrical resistively, density of rocks, soils and sediments, and their hardness.
- **Chemical Characteristics** – geochemistry of rocks, soils and sediments, groundwater, aqueous and fluid phases in the vadose zone.
- **Biological Properties** – nature and abundance of eukaryotic biota, microorganisms, mites, insects and their ecology, and organic compounds.
- **Modelling** to understand the relation between properties and processes.
- **Nature and extent of changes** in the properties and processes with increase in land use density and due to climate changes.

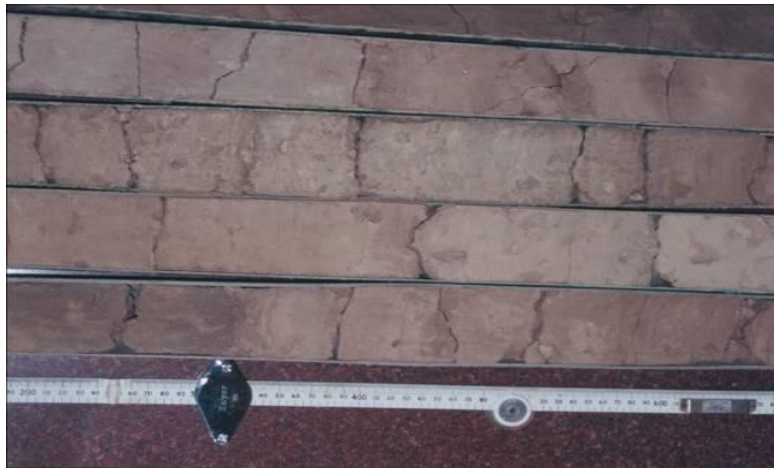
Coordinated Projects in Five Corridors

- Shallow Subsurface Studies in the Ganga Plains – an integrated approach
- A multidisciplinary study of the Shallow Subsurface and the Quaternary Geology of Cauvery Delta region
- Integrated project on the Science of the Shallow Subsurface, Gujarat Alluvial Plain
- Shallow subsurface studies in the south Brahmaputra plains- an integrated approach
- Quaternary geological investigation in Jia Bharali river catchment of North Brahmaputra Plain, Assam: implications for sedimentation, neotectonics and ground water".

Ganga Corridor – Major Objectives



- To understand the evolutionary history of the **mountain exits** of the Ganga river system
- To understand the stratigraphic framework and stratal architecture in the wide **interfluve** of the Ganga and Yamuna rivers
- To understand the surface processes, sub-surface properties and their **dynamics** in an extensively used floodplain
- To develop a **core archive facility** at IIT, Kanpur for preservation, maintenance and management of the drill cores



Ganga Corridor: Project Windows

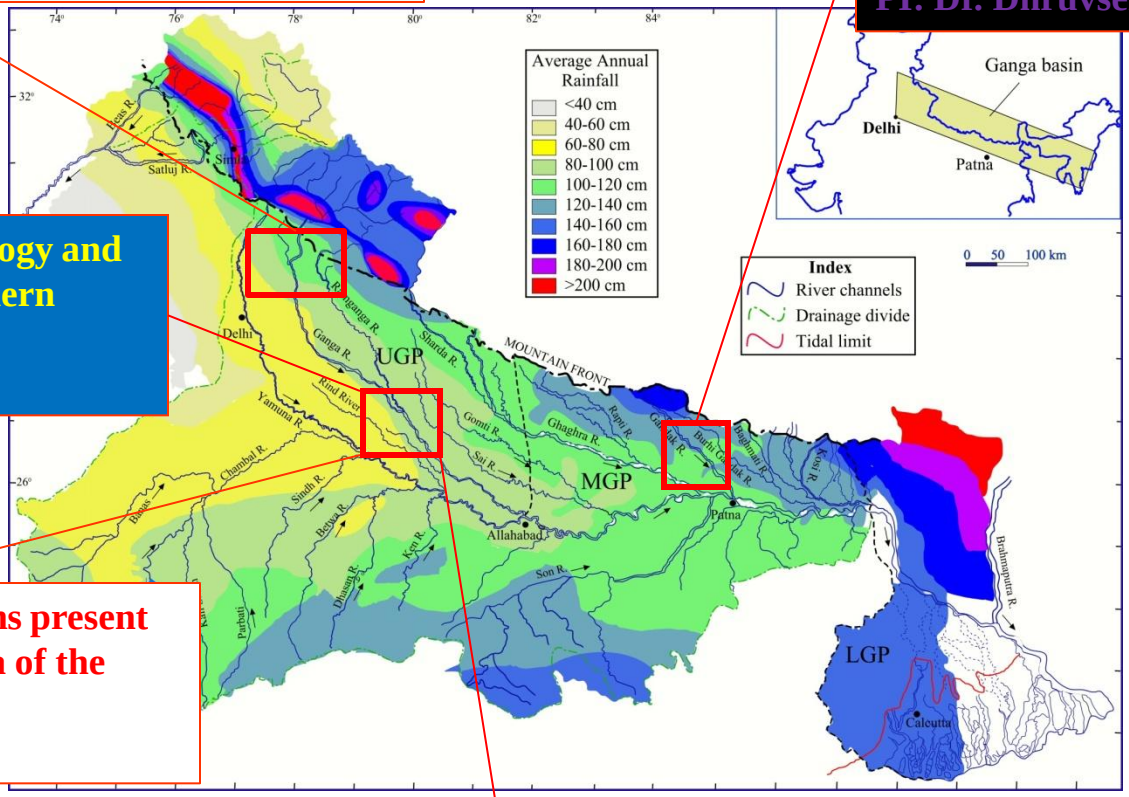
1. Quaternary Tectono-climatic Records of the Ganga basin in the Mountain exits of Himalaya: An Integrated Approach
PI: Dr. Rohtash Kumar

2. Interfluve stratigraphy, sedimentology and geochemistry of the central and southern Ganga plains
PI: Dr. R. Sinha

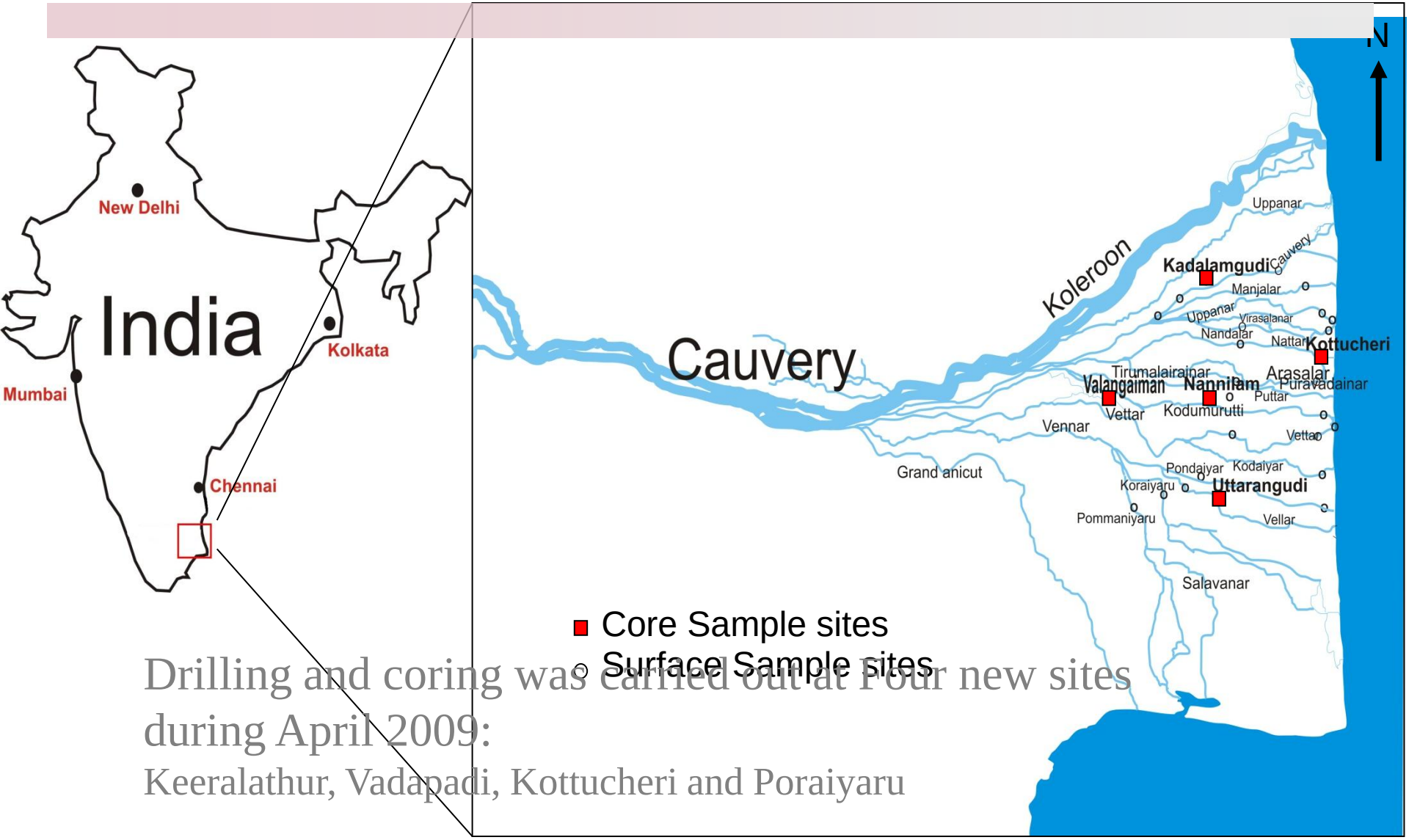
3. Fluvial Dynamics and Sub-surface Stratigraphy of Gandak Megafan
PI: Dr. Dhruvsen Singh

4. Studies on the microbial populations present in the vadose zone in the Kanpur area of the Indo-Gangetic plains
PI: Dr. R. Gurunath

5. Core Archive and Analysis Facility
PI: Dr. R. Sinha



Cauvery Corridor



Drilling and coring was carried out at Four new sites during April 2009:

Keeralathur, Vadapadi, Kottucheri and Poraiyaru

OBJECTIVES

1. To characterize the geological features of the Quaternary strata and their physical and geochemical properties as well as their chronology.

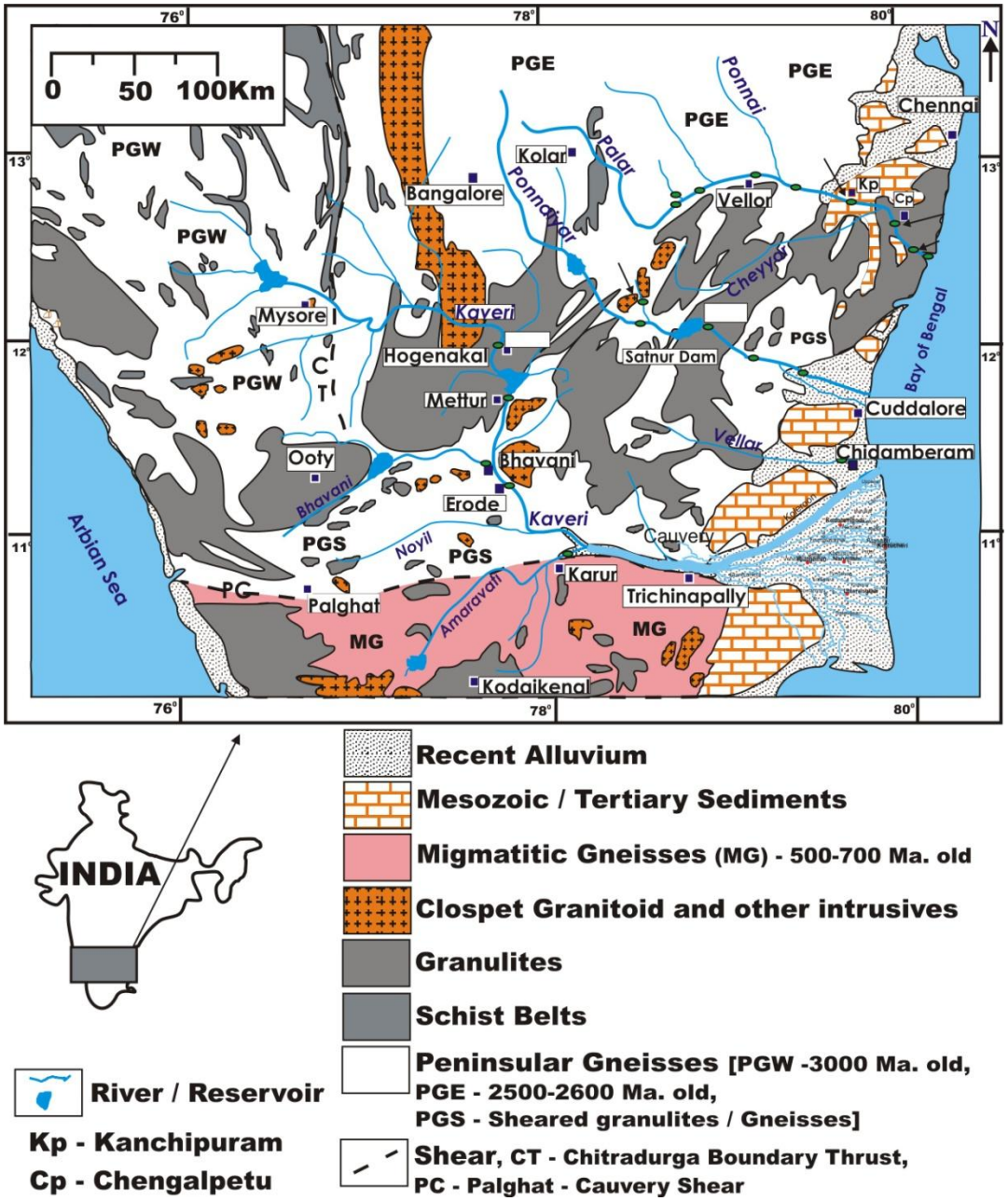
2. To relate the features and properties to tectonic activities and climatic and eustatic changes i.e. geological history of the region.

3 To evaluate the ongoing physical, geochemical and biological processes in the subsurface and their possible effects on the hydrology, agricultural productivity and climate of the region.

Rationale:

✓Understanding physical, chemical, geological and biological properties and processes.

✓This deltaic region is a type area to understand the response of the surface and subsurface to global changes both natural and cultural



Aspects

A. Subsurface makeup & history in terms of tectonics, climate and eustatic change

B. Strengthening and weakening of monsoons

C. Geomorphic mapping / morphostratigraphy

D. Chronology of stratigraphic records

E. Lithofacies mapping

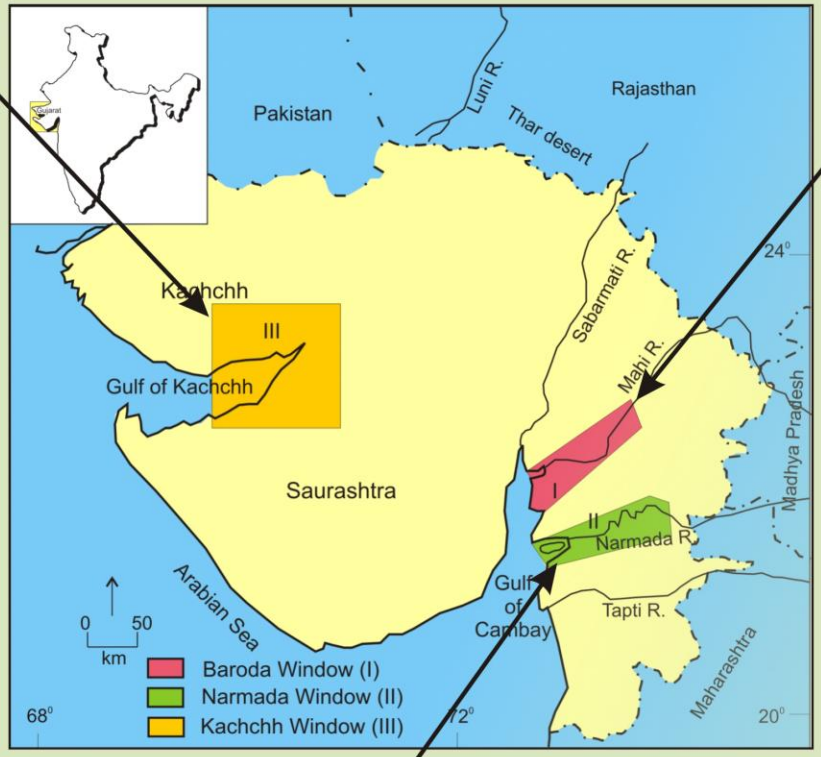
F. Delta building in response to catchment area erosional processes

G. Paleochannel records and mapping of river shifting

Locations and project components of Gujarat corridor

Kachchh Window

- Subsurface stratigraphy of Ranns/ Neotectonism. Dr. D M Maurya
- Neotectonic activity along Transverse faults. Dr. M G Thakkar
- Fault dynamics and seismic potential of KMF and SWF. Dr. G Mathew
- Subsurface bio-turbation patterns. Dr. N Y Bhatt
- Sediment characterization of tidal-flats. Dr. N P Bhatt



Baroda Window

- Physical, geochemical and biological aspects. Dr. Anupam Sharma
- Carbon sequestration in soils. Dr. NSR Krishnayya
- Bacterial community and activity in relation to landuse. Dr. G Archana
- Chemical contamination in vadose zone. Dr. CN Murthy
- Habitat characteristics and ecology of benthic fauna. Dr. KD Vachchhrajani
- Changes in landuse and landcover. Dr. Bindu Bhatt

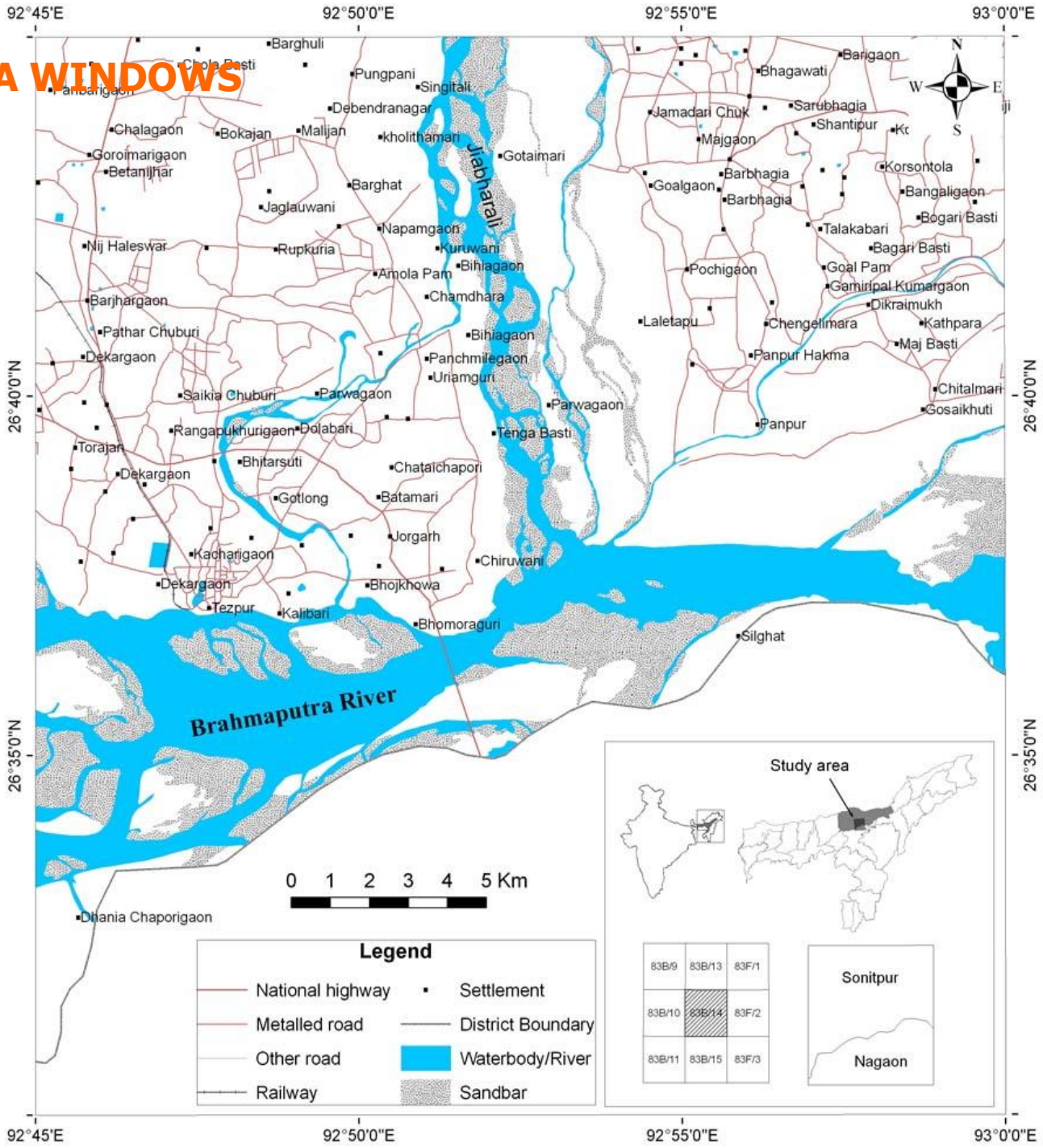
Narmada Window

- Landuse changes and environmental impact. Prof. Jayshree De
- Environmental degradation due to urbanization and industrialization . Prof. NJ Pawar
- Development and management of groundwater resources. Prof. P Dev
- Identification of active tectonic elements/ zones. Dr. P K Verma
- Characterization of heterotrophic and autotrophic micro-organisms. Prof. S R Dave
- Soil carbon dynamics under natural and anthropogenically altered situations. Dr. N Sharma
- Characterization of subsurface sedimentary sequences. Dr. D A Sant

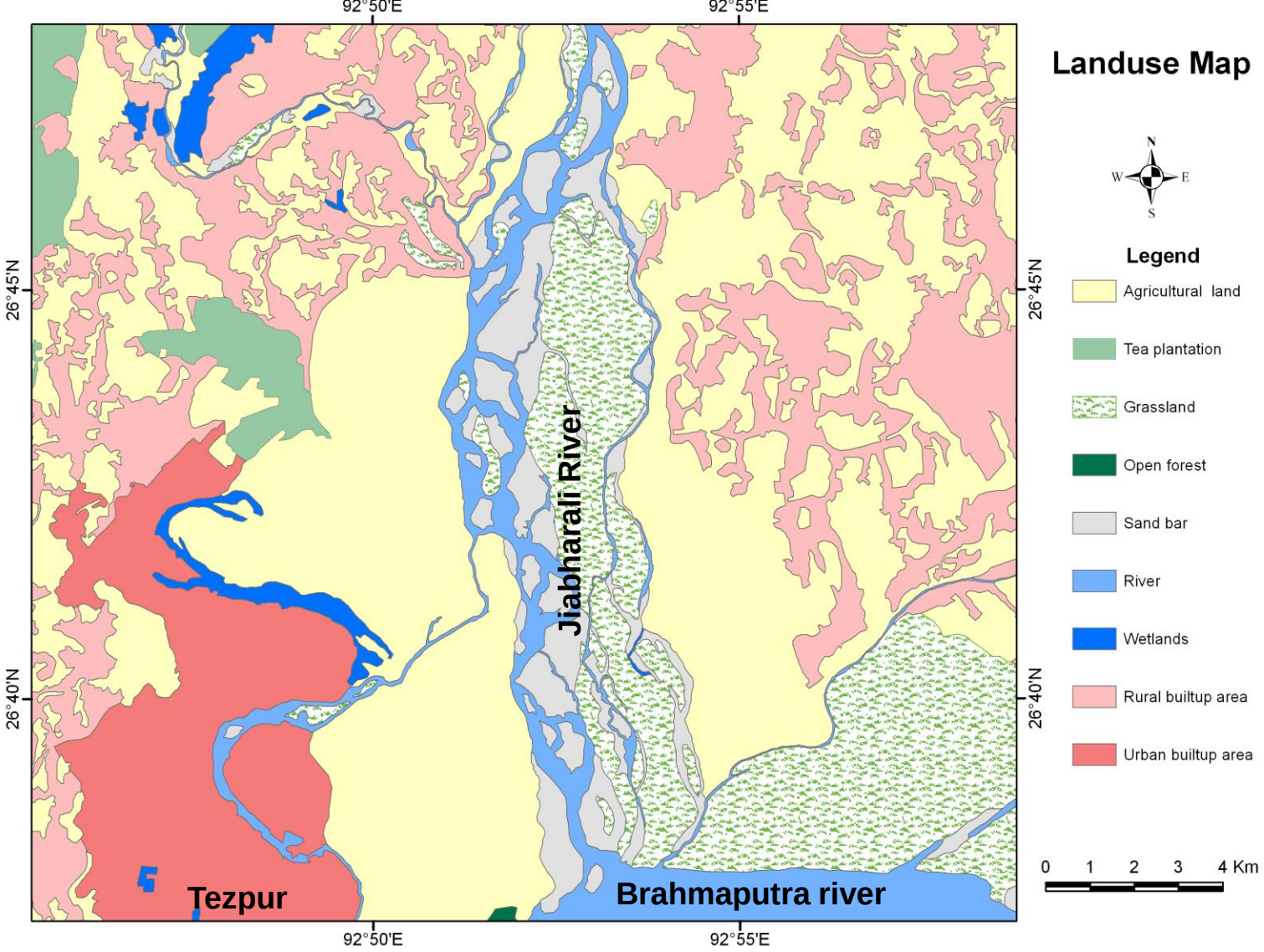
Why Baroda, Narmada and Kachchh Windows

- **Well studied terrains of the country in terms of surface Quaternary Geology and Geomorphology**
- **Formed as a result of continuous Quaternary sedimentation in Rift Basins**
- **Densely populated and form the core of the industrial and agricultural activities in Western India**
- **Kachchh is an earthquake prone area which nullifies developmental works done over decades**

BRAHMAPUTRA WINDOWS



Base map: 1:50K

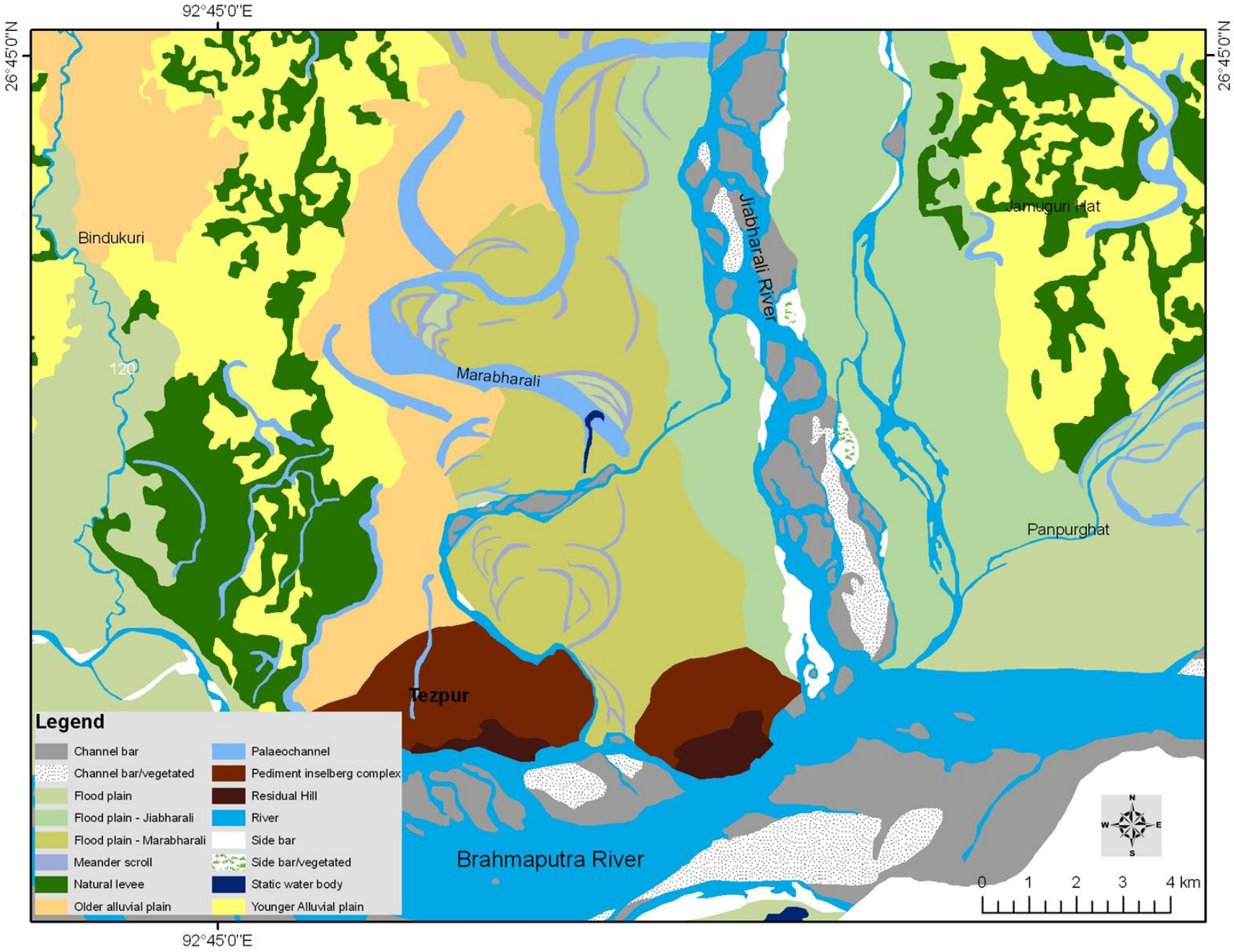


- **Dominant land use: Agriculture,**
- **Population density: 33/ sq. km, (1991 census)**
- **Average annual rainfall ~1600mm with increased rainfall toward north**
- **Discharge in the trunk channel : 6000cumecs**

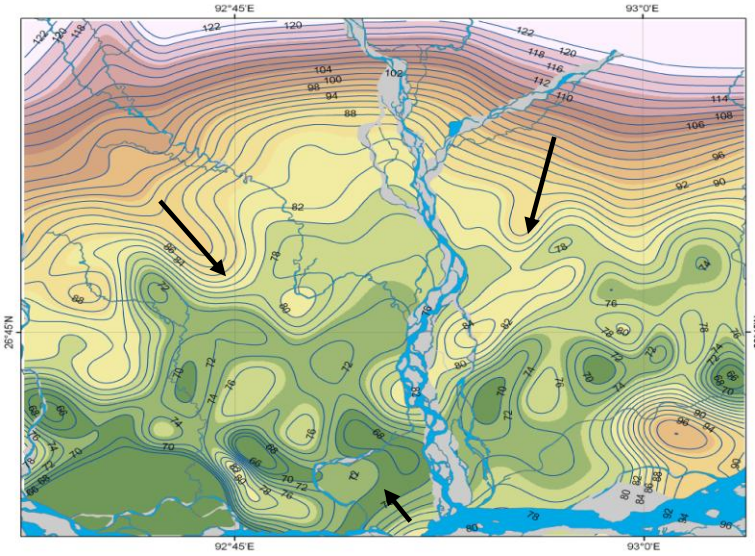
Techniques used

- Electrical Resistivity Tomography (ERT)
- Ground Penetrating Radar (GPR)
- Light Detection and Ranging (LIDAR)
- Environmental Magnetism (EMag)
- High Frequency Seismic Sounding (HFSS)
- 3- D mapping using satellite data and GIS techniques
- Geochemical (Hydrochemical) Mapping
- And also recommend application of geological including radioactive, radiogenic and stable isotopic, soil micromorphological and geomicrobiological techniques

- Direct probe into the shallow subsurface (<100m) through drilling



Floodplains of Brahmaputra andJiabharali with minor landform features

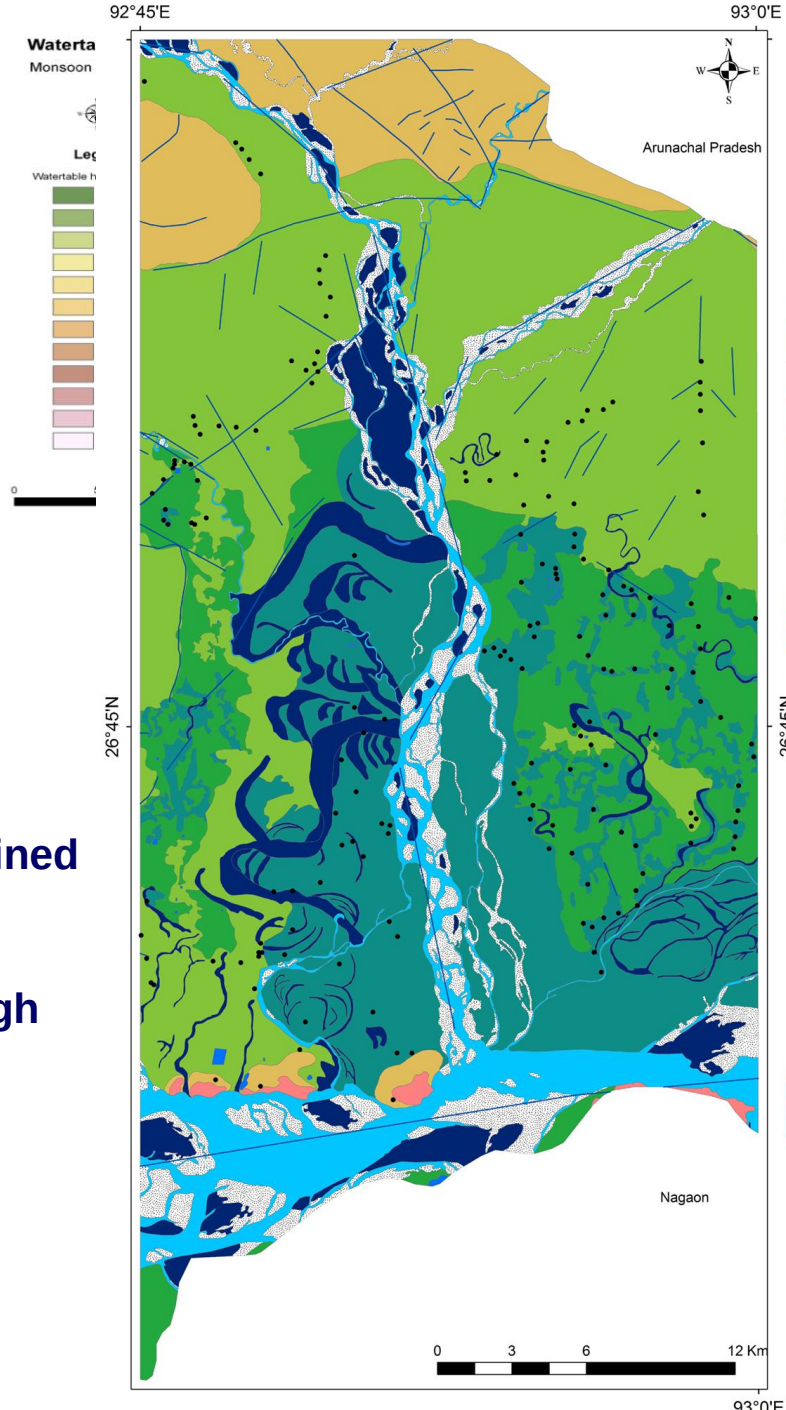


→ **Flow direction**

Aquifer : **unconfined alluvial**

Ground water development : **<20%**

Average yield potential : **very high**

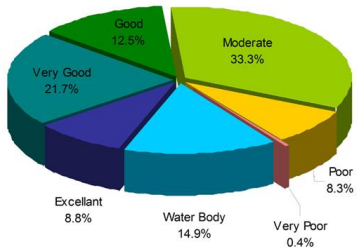


GROUND WATER PROSPECTS MAP

Legend

GWProspect

- Excellent (Yield >800 LPM)
- Very Good (Yield 400-800 LPM)
- Good (Yield 200-400 LPM)
- Moderate (Yield 50-200 LPM)
- Poor (Yield 10-50 LPM)
- Very Poor (Yield <10 LPM)
- River Sand
- Lakes / Ponds
- River
- Structural lineament
- Dug well



DST'S ROLE IN R&D INFRASTRUCTURE DEVELOPMENT

- **In the last 10 years, use of advanced instruments for generating data in various branches of earth sciences has increased many folds.**
- **The advanced geochemical and isotope geo-chronological facilities are considered as basic requirements and available in many Universities in the developed and developing countries, including China.**
- **But in India, the facilities had not grown enough to accommodate the demands of the faculty and research scholars, as many had no access to such sophisticated facility and were forced to depend on laboratories abroad.**
- **This seriously hampered the quality of isotope research in the country and severely restricted training of young researchers in the field of isotope geology.**
- **To overcome the above limitations and to meet the ever increasing requirements of the researchers of India, DST through the SERC focused on creation of the state-of-the-art R&D infrastructure facilities for sustaining research in the academic and research institutions spread over the country.**

2 Programmes of DST for R&D Infrastructure

- **FIST – 'Funds for Improvement of S&T Infrastructure in Universities and other Higher Education Institutions'**

- **IRHPA – Intensification of Research in High Priority Areas for strengthening infrastructure.**

- **Under the FIST, computers, image processing and GIS facilities are created in several universities across the country. In addition, major analytical facilities for carrying out earth science research were also created taking into consideration the research activities in and around the institution, taking commitment from the institution to maintain the system and extend the facilities to the other institutions not only in their region but also from all parts of India.**

- **Under IRHPA, facilities are created around an outstanding scientist to nucleate research activities in certain important / contemporary theme, using advanced techniques / equipments.**

Objectives of IRPHA Programme:

- creation of core groups/units around an outstanding scientist;
- setting up of national facilities in areas of high priority;
- evolving nationally coordinated programmes in multi-disciplinary areas of high priority
- Training to Young Scientists to pursue R&D in these areas.

The National Facilities are expected to provide state-of-the-art experimental and theoretical support to researchers pursuing R&D in the specific area of research. At least 50-60% of the operating time is to be made available to researchers from other Institutions. The Principal Investigator submitting such proposal should identify the Intensive Users of the facility prior to the submission of the proposal to DST along with their technical and financial commitments. The Department also expects it to act as a focal point for R&D and human resource development and training in the specific area of research through regular workshops/ seminars.

FACILITIES ESTABLISHED SO FAR BY DST

National Facilities (11 Nos.)

A. Geochronology and Isotope Geosciences (7)

- Laser Ablation-Multi Collector Inductively Coupled Plasma Mass Spectrometry (LA-MC-ICPMS) - NGRI Hyderabad
- Thermal Ionization Mass Spectrometer (TIMS) – Pondicherry & IIT Roorkee
- Stable Isotope Geochemistry – IIT Kharagpur
- 40 Ar-30 Ar Geothermology – IIT Mumbai
- Isotope Ratio Mass Spectrometry (IRMS) – PRL Ahmedabad
- Low-temperature thermochronology (FT Dating) – Kurukshetra Univ., Kurukshetra

B. Geochemistry (3)

- Electron Probe Micro-Analyzer (EPMA) - IIT, Kharagpur,IIT Bombay, BHU Varanasi
- Inductively Coupled Plasma Mass Spectrometry (ICP-MS) - NGRI
- Geochemical Research (NFGR) - JNU, New Delhi.

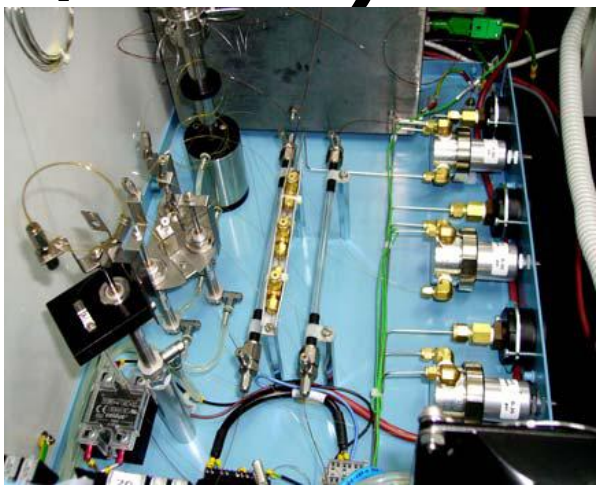
C. Others (1)

- Paleomagnetic Laboratory - Mizoram Univ., Aizawl

National Facility on Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

- This national facility was established at National Geophysical Research Institute in August, 2002. The facility is equipped with a PerkinElmer SCIEX ELAN® DRC-II, Inductively Coupled Plasma Mass Spectrometer (Concord, Ontario, Canada).
- The major objective of this facility was to provide high quality analytical facility for estimation of some of the critical trace elements, rare earth elements (REE), platinum group elements (PGE) and isotopic data required for basic and applied research in the area of earth sciences

National Facility on Stable Isotope Geochemistry (NAFSIG)



- **DST established the NAFSIG at Indian Institute of Technology, Kharagpur in April 2004.**
- **The specific goals of this programme was to provide stable isotope data to other research programmes in the area of paleoclimate and hydrology on collaborative basis.**
- **The IIT facility is equipped with a Thermo made DELTA PLUS XP continuous flow mass spectrometer (CFIRMS) along with several peripheral equipments like Gas bench, Elemental analyser and TC-EA, capable of analysing different types of geological materials including water, carbonate, sulphide/sulphate, organic matter, graphite, clay etc**

LAM-MC-ICP MS National Facility

- This facility at the NGRI supports multi-element isotope geochemistry and geochronology, relevant to basic and applied research in solid earth, ocean and environmental sciences.
- The facility was established in a collaboration mode with funding from CSIR, DST, NIO and NGRI. The facility was formally inaugurated in February 2007.
- The laboratory can facilitate measurements of isotopic composition of some selected trace elements that are difficult to analyze by TIMS, for instance the focus could be on elements such as Li, Mg, Ca, Fe, Cr, Ni, Cu, Zn, Ga, Cd, In, Sn, Te, Lu, Hf, W, Re, Os, Tl, Pb, Th and U.

EQUIPMENTS

MINERAL SEPARATION

1. Jaw Crusher with Disc Mill (Retsch)

2. Wilfley table (Holman, U.K.)

3. Isodynamic Separator (S.G. Frantz)

4. Stereozoom Microscope (Nikon and Leica)

TIMS at IIT, Roorkee

- **The mass spectrometer model TRITON make Thermo Fisher has been installed in this centre in April 2000.**
- **The instrument has very high sensitivity and precision (~ 5 ppm). The abundance sensitivity is also very high (~ 20 ppb) due to the use of energy filter (Retarding Potential Quadrupole).**
- **This enables the measurement of very adverse isotopic ratios such as 230 Th/232Th. T**
- **he facility has excellent clean room for sample preparation. Since the inception of the National Facility, Rb, Sr, Sm and Nd isotopes have been analysed .**

A Thermal Ionization Mass-Spectrometer (TIMS), model Triton of Thermo-Finnigan (Germany) make has also been installed at Pondicherry University in October 2003 to function as a National Facility to serve as an analytical support for Rb-Sr, Sm-Nd and other isotope studies .

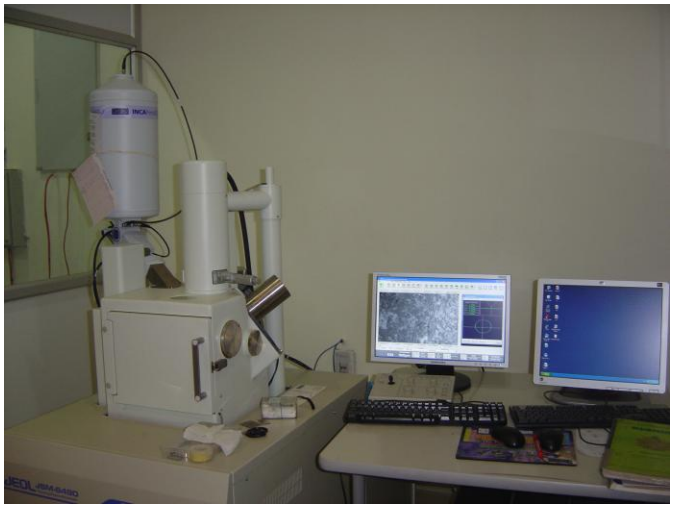
National Programme on Isotope Fingerprinting of Waters of India (IWIN)

- This programme has been launched to address important hydrological questions related to origin of water sources and the processes of redistribution by evapo-transpiration, stream flow generation, ground-water recharge/ discharge – from watershed to continental scale for Indian sub-continent
- Under the above programme, a stable Isotope Ratio Mass Spectrometer (SIRM) Laboratory is being set up at Physical Research Laboratory, Ahmedabad. **Thermo Delta V Plus** with both Dual Inlet and Continuous Flow Modes of analyses are being carried out.

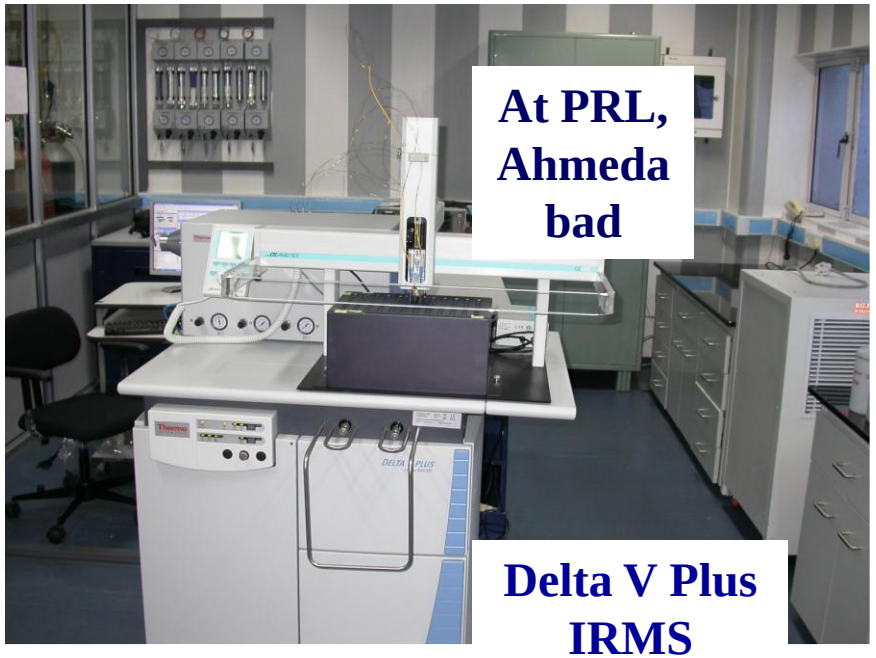
Ar-Ar Geo-Thermochronology Laboratory

- A national centre for Ar-Ar geo-thermochronology equipped with a high-precision noble gas mass spectrometer, is being set up in the Indian Institute of Technology, Bombay to ably complement the other isotope research facilities already established.

Electron Probe Micro Analyser Facility at IIT Kharagpur



- A national facility of EPMA system at IIT Kharagpur where a group of academicians having proven record in this specialized area exist has been established . Five satellite projects set around the National facility have been supported.



Delta V Plus IRMS (Thermo Fisher)

EPMA FACILITY AT IIT BOMBAY

LA_ICP MS System at NGRI, Hyderabad

MC-ICPMS

LA-ICPMS

LA System

MQ System

PP Digestion hoods

PP Column elution hoods

Columns for Sr, Nd, Hf

Rock crushing and powdering equipment

Wilfley table

Sample Dryers

Heavy mineral separation hoods

FISSION TRACK DATING FACILITIES AT KURUKSHETRA UNIVERSITY

- **Himalayan tectonics and exhumation history** is also being attempted through the systematic age determination investigations on the Trans-Himalayan domains and the Higher Himalayan Metamorphic Belt. Therefore, the above National Facility is being set up at KURUKSHETRA UNIVERSITY, KURUKSHETRA.

BUILDING


NATIONAL FACILITY
IN
LOW-TEMPERATURE THERMOCHRONOLOGY
(FISSION TRACK DATING)
DEPARTMENT OF SCIENCE & TECHNOLOGY, GOVT. OF INDIA
DEPARTMENT OF GEOPHYSICS


DR. R.C. PATEL


MICROSCOPE LAB.


DR. VIKAS ADLAKHA


POLISHING LAB.


STORE


ROCK CRUSHING LAB.


MINERAL SEPARATION LAB.


CONFERENCE ROOM

FUTURE THRUSTS

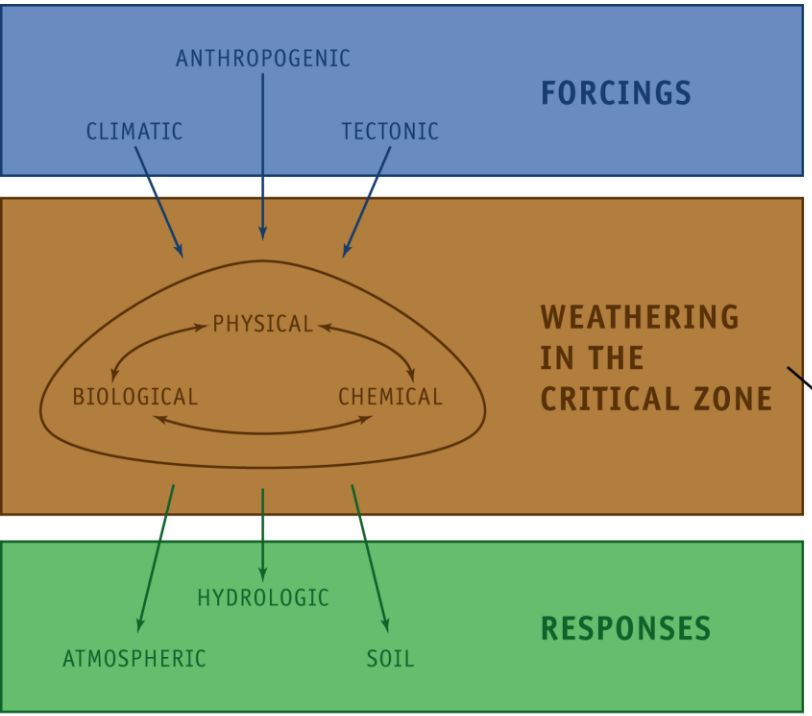
- SHRIMP ?

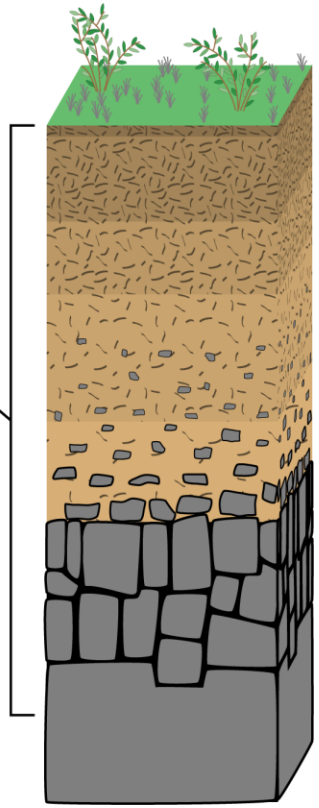
NEW INITIATIVES

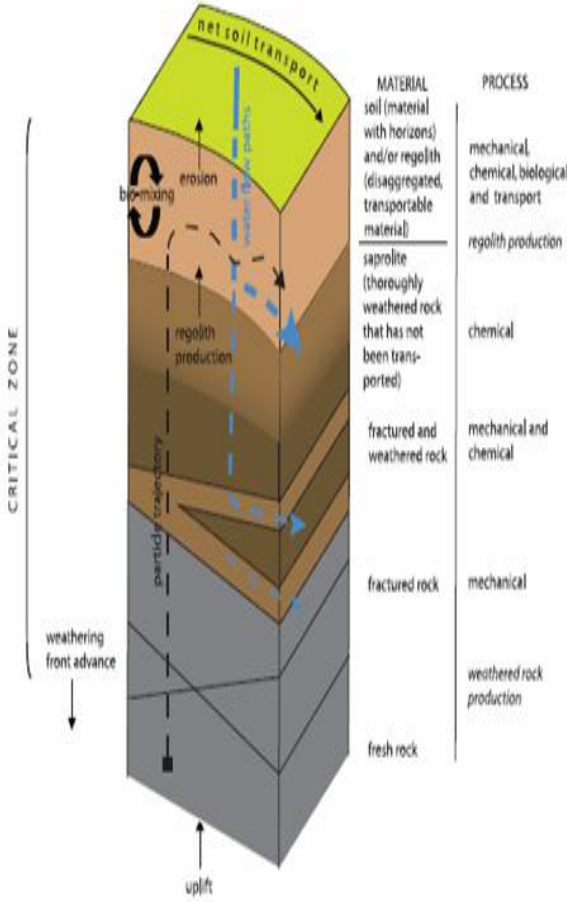
CRITICAL ZONE

- **A complex suite of chemical, biological and physical processes at the Earth's surface combine to create a dynamic system that transforms bedrocks and biomass into soil. Soil is a fragile natural resource that provides for life support and mediates most of the bio-geological and chemical interactions on land surface, groundwater and atmosphere.**
- **The following major Critical Zone Research themes have been identified :**
- **Landform, ecosystem and climate interactions**
- **Soil-landform system**
- **Hydrology and flux flow within CZ**
- **Modern and ancient weathering and erosion system**
- **Geomicrobiology and biogeochemical cycling**
- **Around 10projects on the above theme have been received**

Critical Zone







A complex interactive and interfacial zone involving rock, soil, water, air and living organisms that regulate near-surface chemical and energy fluxes.

Solid Earth Geosciences

- The following two research themes on core areas of solid earth geosciences have been identified:
- (1) Strucutre and collision of Himalayan Collision belt and
- (2) Evolution of Indian lithosphere and the appearance and diversification of life. The details of the modality of the above multidisciplinary program will be discussed during a workshop being organized at Jadavpur University.

A Project Study Proposal

- **It must be well written and be able to convince the person/s to whom it is submitted for approval.**

- **It should show that the project is worth doing, it is feasible, the proponent is competent to undertake the study.**

- **It should be PERSUASIVE, COMPLETE, CLEAR AND FLEXIBLE.**

Quality of Proposal

“One's research is only as a good as one's proposal”

All research proposals must address the following questions

- **What you plan to accomplish?**
- **Why you want to do it ?**
- **How you are going to do it?**
- **What will be missed if the proposed work is not done?**

➢**A good research project may run the risk of rejection simply because the proposal is poorly written.**

➢**Therefore, it pays if your writing is coherent, clear and compelling.**

Objectives of a Research Proposal

- It should be very clear.
- It should not be very broad.
- It should be very specific that should be achievable in 3 years time.
- The problems/ Research questions that you are going to answer in the project should be very specific.
- It should not be very routine type of work.

Thank you

DST is striving to evolve into a new structure to meet

changing substance.

Context of India is changing. Our Content must match.

We promise to serve the Nation even better than

what we have been able to do so far.

Important Websites:

- DST Main Website: www.dst.gov.in
- SERB www.serb.gov.in
- SERB Online www.serbonline.in
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- SEED www.scienceandsociety-dst.org
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