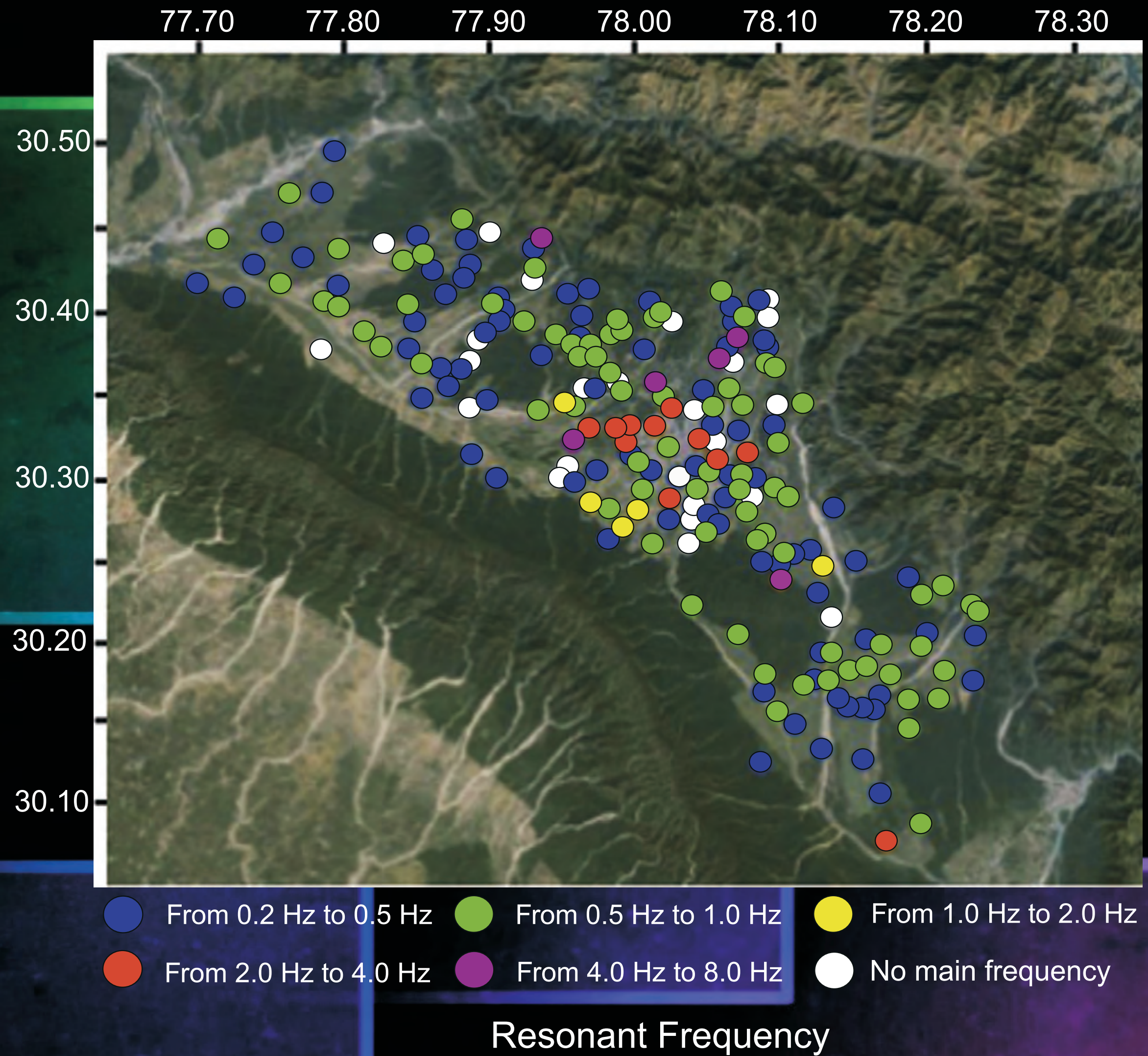
ANNUAL REPORT 2014-15



WADIA INSTITUTE OF HIMALAYAN GEOLOGY
DEHRADUN
(An Autonomous Institute of Dept. of Science & Technology, Govt. of India)

Cover photo: Map of fundamental resonant frequencies along the Doon Valley, shown in different colours.
(Courtesy: A.K. Mundepi)

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DIRECTOR

RESEARCH ACTIVITIES

RESEARCH GROUPS

- Structure & Tectonics
- Igneous Petrology & Geochemistry
- Sedimentology
- Biostratigraphy
- Geophysics
- Geomorphology& Environmental Geology

THRUST AREA THEMES

- Geodynamic Evolution of the Himalaya and Adjoining Mountains
- Indian Monsoon-Tectonic Interaction and Exhumation of the Himalaya
- Earthquake Precursors Studies and Geo Hazard Evaluation
- Biodiversity - Environment Linkage
- Himalayan Glaciers: their role in Indian Monsoon variability and Hydrological changes in the Ganga Basin

UNITS ANCILLARY TO RESEARCH

- Research Planning & Co-ordination Cell
- Publication & Documentation
- Library
- Museum
- Drawing Section
- Photography Section
- Instrument Maintenance
- Sample Preparation Section

ADMINISTRATION

- Registrar's Office
- Finance & Accounts
- Establishment
- Stores & Purchase
- Works, Building & Maintenance
- Transport
- Guest House

INSTITUTE HIGHLIGHTS

The Wadia Institute of Himalayan Geology strives continuously to unravel the geological truth related to building of majestic Himalaya with a purpose to improve our understanding of geodynamic processes, climate-tectonic interactions, evolution and extinction of life, processes of ore formations, and glacier melt water contribution to river systems. Its research activities are grouped into 5 Thrust Area Themes (TAT) that are implemented through long-term and short-term projects of the Institute. These are supplemented by sponsored projects focused at various themes within the ambit of the evolution and geodynamics of the Himalaya.

TAT-1: Geodynamic Evolution of the Himalaya and Adjoining Mountains

TAT-2: Indian Monsoon-Tectonic Interaction and Exhumation of the Himalaya

TAT-3: Earthquake Precursors Studies and Geo Hazard Evaluation

TAT-4: Biodiversity- Environment Linkage

TAT-5: Himalayan Glaciers: their role in Indian Monsoon variability and Hydrological changes in the Ganga Basin

An overview of the on-going activities shows that the year 2014-15 witnessed all around progress in all the research projects and has yielded interesting and useful results. The impact factors and number of citations have increased significantly. The glimpses of the prominent achievements in respective themes are summarized below:

TAT - 1: Geodynamic Evolution of the Himalaya and Adjoining Mountains

- Stress tensor Inversion results obtained from Fault plane solutions, shows E-W extension (minimum stress axis) in Kinnaur region, as shown by T-axes of the Fault plane solutions of the region.
- The reconstructed P-T evolution suggests that the Shergol blueschists are the result of cold subduction along a thermal gradient of ca. 5-6°C/km, and that such a low geothermal gradient was followed also during exhumation.
- A new demarcating line separating between Outer Lesser Himalaya (OLH) and Inner Lesser Himalaya (ILH) is proposed and accordingly, the pre-Blaini sedimentary succession of OLH represents younger (Neoproterozoic) and ILH older (Palaeo-proterozoic-Mesoproterozoic) part of the Garhwal-Kumaun Lesser Himalaya. The Lesser Himalayan Proterozoic succession appears to be similar to the rift-controlled basinal setting of the Aravalli, Dharwar and other early to middle Proterozoic basins of Peninsular India, and the Neoproterozoic OLH with Vindhyan System.
- Deformation and partial melting of the Ladakh Batholith contributed to the leucogranite magmatism in the Karakoram Fault Zone. The age of initiation of the Karakoram Fault envisaged being at least 23 Ma.
- The *P-T* calculation of hornblende based substitution mechanism, shows that the amphiboles of the mafic xenoliths from the Sutlej valley, NW Himalaya have equilibrated in the temperature range of 550-650ºC and pressure range of 3.0-7.5 kbar.
- Single grain fusion $^{40}Ar/^{39}Ar$ muscovite data from samples either side of the Zimithang Thrust yield ages of ~7 Ma, suggesting that movement along the thrust juxtaposed the two lithotectonic units of the Greater Himalayan Sequence in Arunachal Pradesh by the time the closure temperature of Ar diffusion in muscovite has reached.
- The chemical studies of the thermal waters of Tapovan, Bhenti, Darr, Shera, Devibagar and Pangla hot water springs from Chiplakot Crystalline Belt (CCB) of NE Kumaun Himalaya are attributed to have originated from different reservoirs. The water chemistry and $\delta^{18}O$ signatures imply involvement of chemically immature, meteoric water in the formation of hot springs.

TAT-2: Indian Monsoon-Tectonic Interaction and Exhumation of the Himalaya

- Sedimentary architecture and Optically Stimulated Luminescence (OSL) chronology studies of the sand ramps of Ladakh, suggests that in Ladakh Himalaya aridity and aeolian activity was dominant during 25-17 ka and <12-7 ka, and wetter conditions, as evidenced from interdunal lake

INSTITUTE HIGHLIGHTS

INSTITUTE HIGHLIGHTS

formation and fluvial gullying, prevailed at ~12 ka to 7 ka. These dry and wet phases correspond to variations in SW monsoon strength.

- In the Satluj River valley, in the hanging wall of MBT, six levels of terraces (T1 to T6) were identified. The terrace chronology shows they were deposited under different time intervals during late Pleistocene and Holocene. The lithology of topmost terrace (T6) is very unique and was deposited between 50 and 70 ka.
- The ^{14}C AMS method age-dating of Tso-Moriri lake core samples suggests that it had experienced a cold and wet climate phase during ca 1650 to1850 AD. This event has an abnormal trend of climate in this dry and cold desert region, which can be explained by the shift in circulation pattern in the influence of Inter-Tropical Conversance Zone (ITCZ) and expansion of tropics.
- Tree cores of sixteen *Picea smithiana* from Tela camp, Dokriani glacier, Dingad valley were processed, dated and measured with an accuracy of 0.001 mm, and ring-width chronology was developed extending back to AD 1656.
- The variation of $\delta^{13}C_{VPDB}$ measured in Dissolved Inorganic Carbon (DIC) with concentration of SiO_2 in Indus River waters shows that the alkalinity in these rivers is linked with silicate weathering.
- Lacustrine deposits from Tso Moriri Lake, Ladakh and speleothem carbonates from Meghalaya were examined to understand changes in the Indian summer monsoon since the MIS3. The record shows a strong 1700 yrs cycle in monsoon variability.

TAT-3: Earthquake Precursors Studies and Geo Hazard Evaluation

- The preliminary 1D velocity model for Himachal Pradesh, India has been obtained by utilizing the travel-time inversion of P and S phases of the seismic waves.
- The microtremor H/V studies along with the estimation of the Vs profiles in Doon valley suggested a shallow low-velocity layer in the central region with a velocity between 120 and 165 m/s. Such low-velocity layers indicate the soft sediments (class E), the probable higher seismic hazard regions.
- The distribution and relative placing of various lithological units and pattern of deformation in the trench excavated across the Logar Fault, in the Kumaun Himalaya suggest normal faulting. The mappable length (7.5 km) of the Logar Fault indicate that it is not long enough to produce a great earthquake (Mw >8). However, it is capable of generating secondary faulting and further deformation in the hanging wall.
- Late Quaternary shortening rates on the Jawalamukhi Thrust (JT), the Soan Thrust (ST) and the Himalayan Frontal Thrust (HFT) are estimated. The results constrained the shortening to be distributed largely across a 50 km wide zone between the JT and the HFT, and indicate that the high magnitude earthquakes can occur between the locking line and the active thrusts.
- The Himalayan Frontal Thrust in the Ramnagar-Kaladhungi segment of the Kumaun Himalaya is morphogenic in nature with the development of 21 km long escarpment with a maximum height of 120 m.
- The quantification of various geo-engineering properties, mainly the strength characteristics of soil and rocks of the Mussoorie and Nainital townships were carried out. The slopes around the Surabhi Resort landslide have also been monitored with Total Station, and it has been observed that there is continuous movement on the slope, and demands an immediate intervention on the slope for its corrective measures.

TAT-4: Biodiversity - Environment Linkage

- Chert samples of Krol 'A' Formation exposed in Khanog and Rajgarh synclines of Himachal Pradesh, record well developed and diversified assemblage of Ediacaran large acanthomorphic acritarchs which show a close resemblance with the upper Doushantuo or *Tanarium anozos-Tanariumconoideum* assemblage of China. The stratigraphic similarities also suggest a coeval deposition of the Krol 'A' and Doushantuo formations.
- Trace fossils and Microbially induced sedimentary structures (MISS) are first time documented from the early Cambrian succession of Chandratal section in Spiti Basin, mostly formed in the shallow marine settings by interaction of microbial mats with the physical dynamics of sediments. They can be used as an element to define the ancient life, and also as an indicator of interaction between microbes and depositional environments.

- Ichnofossils of the Indo-Myanmar range from the Barial Group of Oligocene age indicate shallow marginal marine environment for the formation.
- A rich mammalian assemblage was recovered from the Middle Siwalik Subgroup of Kangra Valley (HP). From the palaeobiogeographic analysis of the faunal assemblage it was opined that the bulk of the mammalian assemblage corresponds to the Turolian Land Mammal successions of Europe and its equivalents in Africa.
- A new sample of *Cambaytherium thewissi* is documented from the early Eocene Cambay Shale Formation of western Peninsular India. The cambaytheres are basal members of the clade including perissodactyls. The presence of the sister group of perissodactyls in western India near or prior to the time of collision suggests that perissodactyla may have originated on the Indian Plate during its final drift toward Asia.

TAT-5: Himalayan Glaciers: their role in Indian Monsoon variability and Hydrological changes in the Ganga Basin

- The snout of the Dokriani glacier was monitored by GPS with reference to permanent survey point made on both the sides of the glacier front, and it is observed that the results of snout retreat were comparatively more than the previous years (between 12-16 m/yr).
- Attempt has been made to estimate the spatial and temporal variability of the surface ice melting (Energy Mass Balance) on the debris-covered ablation zone of the Chorabari Glacier, and the studies suggest that energy mass balance (EMB) at the glacier surface was highly influenced by the snow accumulation and supra-glacial debris characteristics.
- Landslide mapping has also been carried out in the lower reaches of the Bhagirathi valley around Uttarkashi township. It has been observed that in a stretch of about 28 km between Bhatwari and Uttarkashi, 23 active landslides were present.
- A comprehensive geochemical database of Udham Singh Nagar area covering four major catchments: Sarda, Kosi, Gola and Phikka were prepared allowing us to reasonably define base line with respect to which the future environmental changes can be quantified. The studies suggest no appreciable and detectable degradation of the surface environment.
- Isotopic compositions of dissolved inorganic carbon ($\delta^{13}C_{DIC}$) in the thermal spring waters of the Garhwal, Himachal and Ladakh regions show a wide range of variations from -8.4 to +4.1‰. Such highly enriched values of $\delta^{13}C_{DIC}$ are indicative of metamorphic de-carbonation reaction for contributing CO_2 to the fluids.

Academic Pursuits

Under the on-going research programs pursued during the year, the Institute has published 72 research papers both in international and national journals out of which 51 are in SCI journals, with around 72 papers being in press or communicated. Seven research scholars were awarded Ph.D degree, while four theses have been submitted for the award. Twelve scientists have also visited abroad to participate in various seminars/ symposia/ workshops/ training courses.

The Institute further continued to provide laboratory facilities to sister organizations, academic institutions, particularly the students. During this year the Institute continued the publication of the journal '*Himalayan Geology'*, and brought out the volumes 35(2) and 36(1), along with newsletter 'Bhugarbh Vani' volume 4 (Nos. 1-3) and volume 5 (No. 1). The abstracts of the journal Himalayan Geology for the year 2015-16 are now being published in Hindi and English.

Other Highlights

Hindi pakhwara was celebrated in the Institute from September 14-28, 2014, during which essay competitions and debates for school children and Institute employees were organized. General orders, circulars and notices were issued in Hindi as well as in English. The Annual Report of the Institute for the year 2013-14 was published in bilingual form (Hindi and English). Various incentive schemes for encouraging progressive use of Hindi were also implemented.

Anil K. Gupta
Director

TAT - 1: GEODYNAMIC EVOLUTION OF THE HIMALAYA AND ADJOINING MOUNTAINS

TAT - 1.1
Himalayan Deep Image Profiling (HIMDIP) along defined transects

(*S.S. Bhakuni, Gautam Rawat, Naresh Kumar, Dilip Kumar Yadav and Devajit Hazarika*)

Magnetotelluric (MT) studies in the North-western Himalaya

Magnetotelluric data at ten sites in the Satluj River valley (Fig. 1) have been acquired for the purpose of defining geoelectrical structure of the region. Conductivity, a transport property of the material, defines the ease with which the electric current flows. The flowage of the electric current at an atomic level depends upon the mobility of charged particles, which in turn, is influenced by the temperature. Therefore thermal structure of the earth is reflected in the earth's conductivity profile. In addition, the presences of aqueous fluids, metallic, carbon or sulphide content are other factors that affect the bulk electrical conductivity of subsurface rocks. As observed in the seismic studies, there are two seismogenic zones in the study region. One is associated with Himalayan Seismic Belt and another is controlled by the Kaurik-Chango Fault Zone (KCFZ). In the Garhwal Himalaya, the seismicity in the Himalayan Seismic Belt is associated with high conductance ramp that symbolizes block of low shear strength and high degree of strain, which under the deviatoric stresses releases accentuated stresses into the brittle crust to generate small but more frequent earthquakes in the narrow Himalayan Seismic Belt. The time series observed at ten sites are being processed for getting smooth MT transfer functions using variety of methods. These transfer function will then be modelled for subsurface resistivity distribution.

Seismic studies in Himachal Himalaya

A high seismic activity of micro-earthquakes has been observed in the Kinnaur region of the NW Himalaya. This activity within the South Tibetan Detachment (STD) zone is a unique feature compared to other

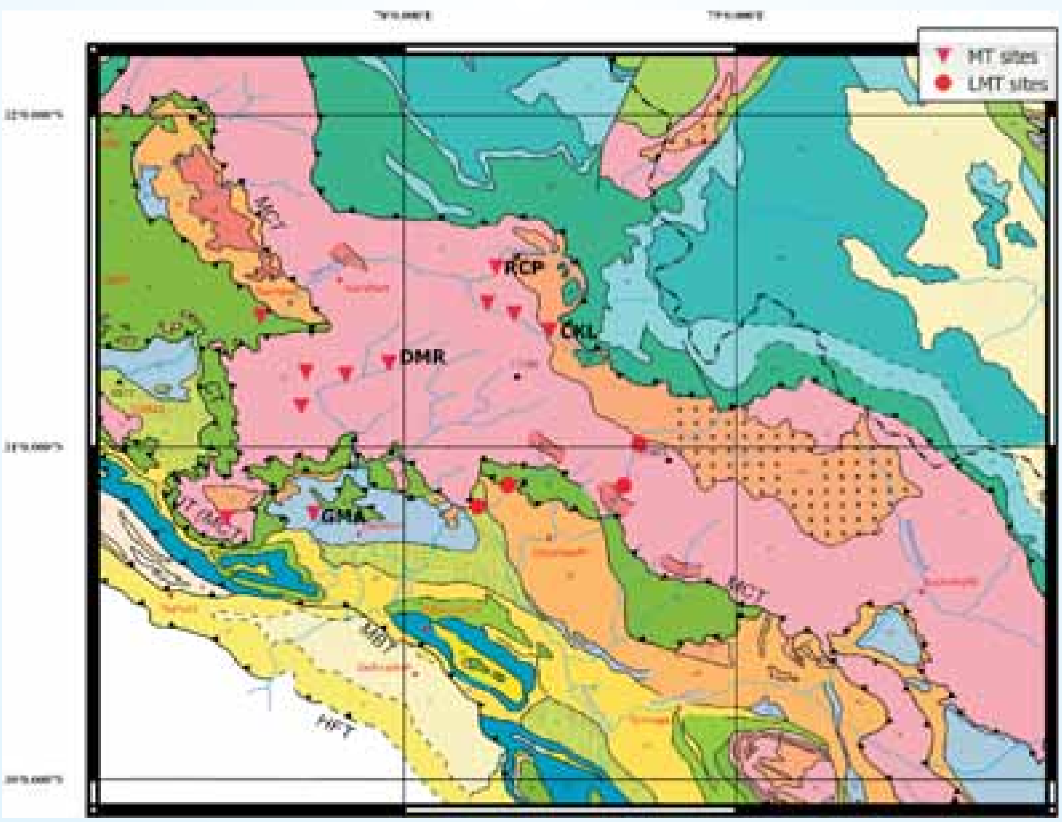

Fig. 1: Geological Map (Thakur & Rawat 1992) showing location of MT sites in the Satluj river valley.

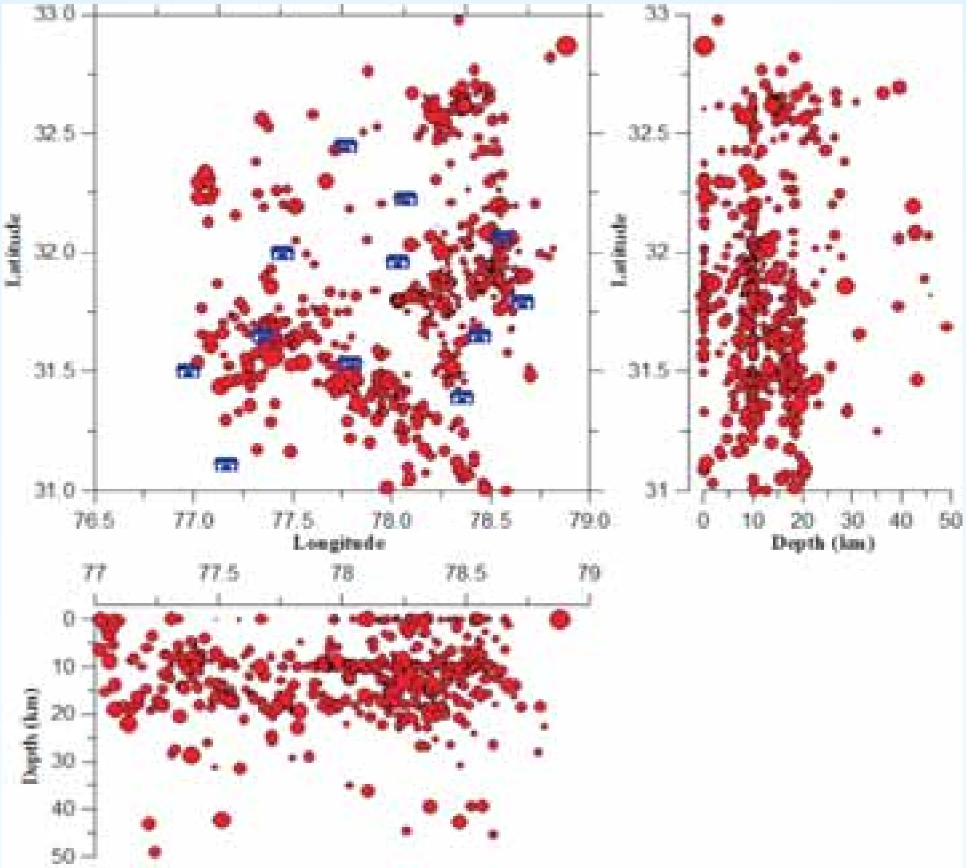

Fig. 2: Recent micro-earthquake activity of Kinnaur region of NW Himalaya. Epicenter locations, stations locations and hypocentre locations are given.

similar regions of the western Himalaya. In order to understand the seismotectonics of the region, the recent micro-earthquake data is analysed, which is recorded by a local braod band seismic network. Over 600 earthquakes with magnitude range 1.0 to 4.0 were relocated using revised velocity model of the region. The spatial pattern of earthquakes was integrated with available geological, geophysical, geomorphological data and observations following the M6.8 earthquake of 1975. Main emphasis is given to delineate and identify the geometry of seismogenic structures. The integration of different studies with seismicity suggests that the area lying to the north of Main Central Thrust (MCT) and close to the STD can be divided into several seismogenic crustal blocks, underlain by a fluid-filled fracture zone.

Broadly, the region can be divided into two main seismogenic zones (Fig. 2). The first zone is located in the southern part of study region in which the seismicity is aligned in WNW-ESE and is concentrated close to the MCT. This seismicity is part of the Main Himalayan Seismic Belt (MHSB) and is generated by major tectonic features of the Himalaya. Another zone is located in the eastern part and the seismicity is nearly N-S aligned that is the unique feature of the study region. The seismicity is bounded to the west by the Kaurik-Chango Fault Zone (KCFZ), which dips steeply towards west. The KCFZ is aligned nearly N-S direction perpendicular to the major tectonic features of the Himalaya. This alignment direction coincides with the strike of the focal mechanism of the 19 January 1975 Kinnaur earthquake. The seismicity is mostly in the crustal part upto a depth of ~40 km, with hypocentral depth increases towards north. The seismogenesis zones are mainly located between 15 and 25 km depth, which is also the location of the larger events (M4) in this zone.

Stress pattern investigation of Kinnaur region, North-western Himalaya

The focal mechanisms of local and regional earthquakes of magnitudes ≥3.0 have been used for the determination of seismotectonics and stress pattern of the northwest Himalaya. The earthquake recording from the Kinnaur seismic network during 2008-2010 and the focal mechanism of past big size earthquake data taken from USGS have been used for the present study. The normal faulting stress regime prevailing in the Kinnaur region has been reported in northeast corner of the Kumaun region, which is in contrast to the compressional stress regime prevailed in other parts of the Himalaya. The inferred fault-planes trend is along N-S direction with their T-axes along E-W direction indicating existence of extensional regime of the northwest Himalaya. The effect of this E-W extension is considered to be the part of the STD zone and is related with the Kaurik-Chango normal fault. The stress tensor inversion (STI) study shows extensional stress regime in the Kinnaur region. It shows the normal type of faulting with misfit amounting to 1.5 and stress magnitude ratio (R) of around 0.5. The maximum principal stress axis ($\sigma1$) trends 290º with steep plunge of 66º, intermediate principal stress ($\sigma2$) trends 195º with plunges of 2º and least principal stress axis ($\sigma3$) trends 104º with shallow plunges of 23º. Similarly for northeast corner of the Kumaun region, the maximum principal stress axis ($\sigma1$) trends 43º with steep plunge of 56º, intermediate principal stress ($\sigma2$) trends 177º with plunges of 25º and least principal stress axis ($\sigma3$) trends 278º with shallow plunges of 21º. The STI results of the Kinnaur region and northeast corner of the Kumaun region near Nepal thus shows extensional stress regime with NW-SE extension direction.

The seismic activity of the Kinnaur region (Fig. 3) follows the trend of Kaurik-Chango fault which extends roughly in N-S direction and T-axes directions obtained from fault plane solution show NW-SE direction.The tectonic activity of the NW Himalaya portrayed through the fault plane solutions (FPS) indicate a general trend of thrusting of the Himalaya, however, there are certain deviations on regional scale. Two regions near the STD zone show extensional activities and the trend of these activities are perpendicular to the general trend of the major tectonics (i.e., the MBT and MCT) of the

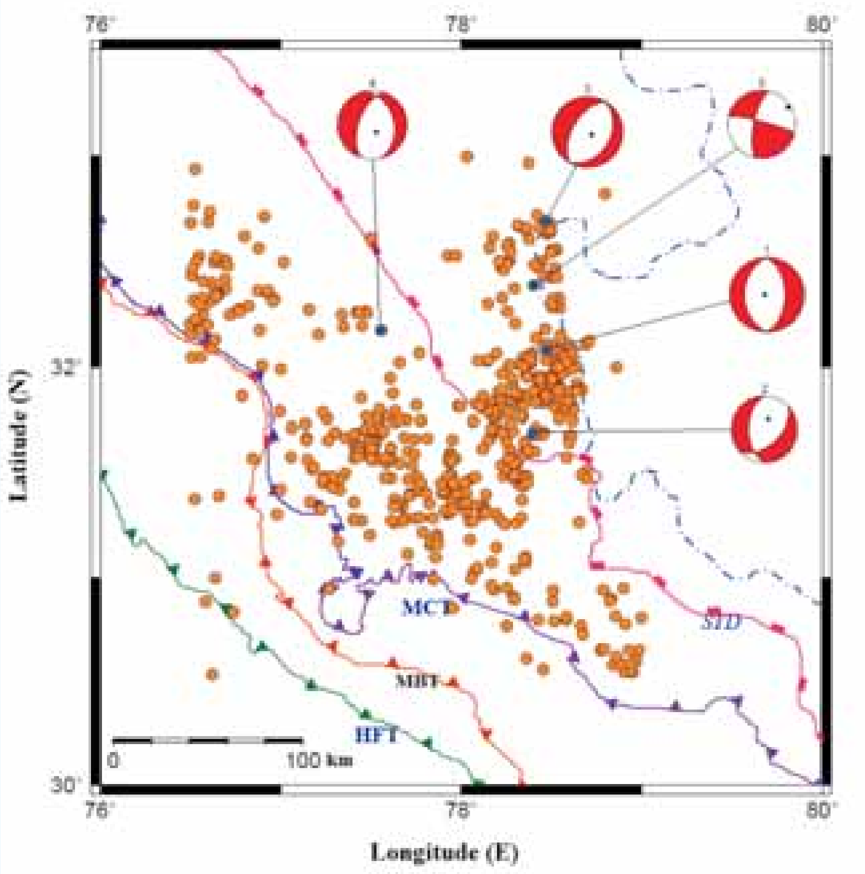

Fig. 3: Micro-earthquake activity recorded by Kinnaur Network of WIHG, Dehradun with major tectonic features of NW Himalaya such as Himalayan Frontal Thrust (HFT), Main Boundary Thrust (MBT), Main Central Thrust (MCT) and South Tibetan Detachment (STD). The fault plane solutions of five earthquakes (USGS) showing normal faulting mechanism with T-axis orientation in NW-SE direction are also indicated.

Himalaya. It is inferred that these two regions, i.e. the Kinnaur and northeast corner of the Kumaun Himalaya cause additional stress in parts of the Himalayan zone resulting in the variation of seismicity along the strike.

Shear wave velocity structure beneath a broadband seismic profile across the Himachal Himalaya

In continuation with the passive seismic experiment carried out in the eastern Ladakh and Satluj river valleys (using 20 station data from the Ladakh and Kinnaur networks) as reported earlier, a seismological network consisting of nine broadband seismograph stations has been established across the Himachal Himalaya. This profile extends from Tapri, (Dist. Kinnaur, Himachal Pradesh) in the north to the Himalayan Frontal Thrust (HFT) to the south. The stations are namely Tapri (TAPR), Rampur (RMPR), Digadhar (DIGA), Sadhora (SADH), Kandaghat (KGHT), Chikkon (CHIK), Ramgarh (RMGR) and Bhagpur (BHAG) (Fig. 4). The seismic data recorded by TAPR, RMPR, DIGA and SADH stations largely sample the Satluj River valley whereas, the seismic data by seismic stations GARH, KGHT, RMGR, CHIK and BHAG located to the south of the profile facilitate to explore crustal structure in and around the HFT and Main Boundary Thrust (MBT). About 150 teleseismic data have been extracted from the seismograph stations of the profile recorded during the period between September 2013 and December 2014 and analysed using receiver function (RF) method of Liggoria and Ammon (1999). The distribution of earthquakes used in this study is shown in the inset of figure 4.

Individual RF data along with stacked receiver functions computed at TAPR station, as an example, is shown in figure 5. Most significant feature of RFs at TAPR station is the Moho converted P- to S- (or PS) phase identified at ~6.5 s and another positive arrival at ~3.5 s indicating a mid-crustal layer. To trace the crust and intra crustal features along the profile, a time section plot of RFs has been prepared, where most of the stations clearly indicates increase of crustal thickness from south to north of the profile. Moreover, a mid-crustal layer has been identified at ~2.5-3.5 s in the time section plot, which may correspond to the Main

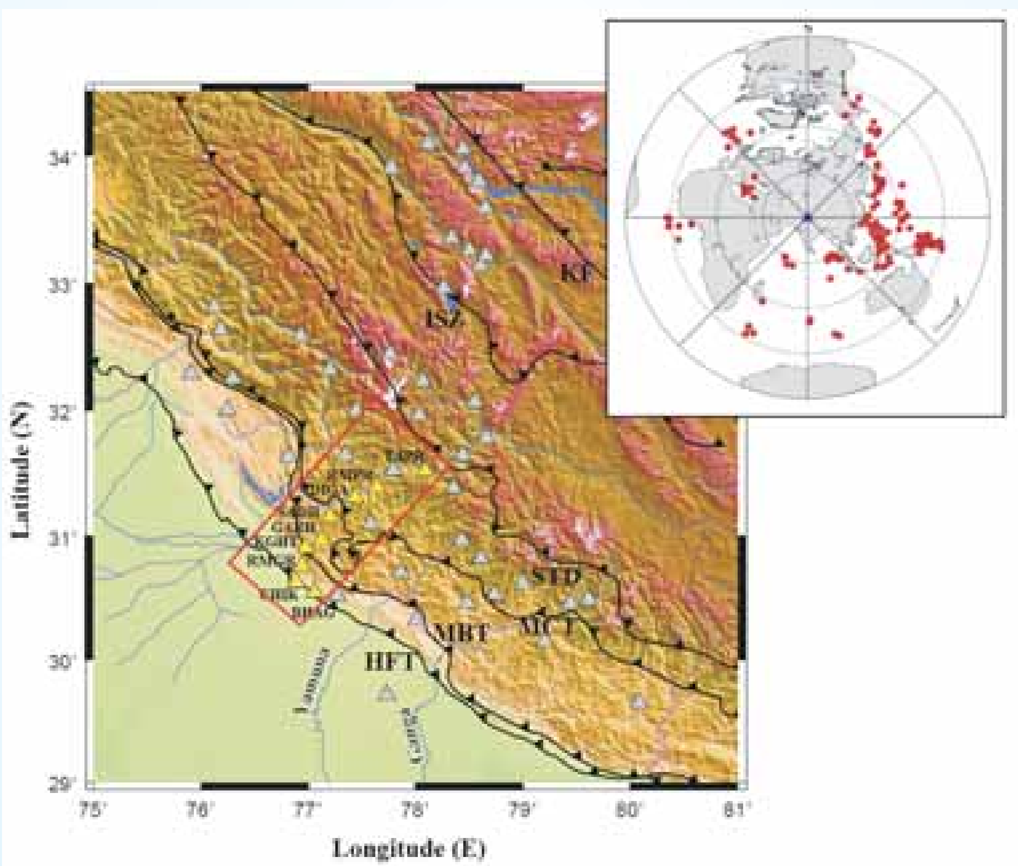

Fig. 4: Map showing major tectonic features of the northwest Himalaya with broadband seismological stations of WIHG, Dehradun (triangles). The red rectangle shows the study area.

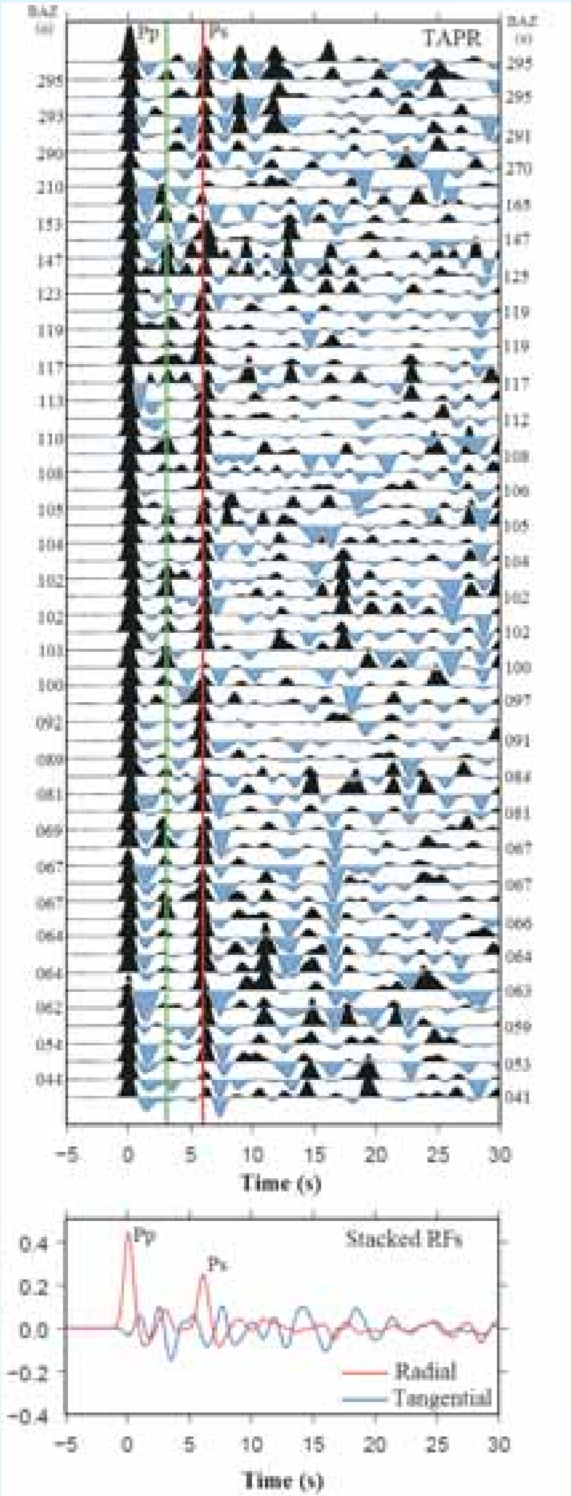

Fig. 5: Plots of (a) individual RFs of TAPR station as a function of back azimuth (BAZ) after distance move out correction for the Ps phase to a reference distance of 67and slowness 6.4 s deg^{-1}. The stacked radial (red) and tangential (blue) RFs is shown in (b). The significant energy in the tangential component before the Ps phase indicates existence of crustal anisotropy.

Himalayan Thrust or detachment plane as reported by earlier studies.

Preliminary observations indicate the presence of mid-crustal low shear wave velocity zone for the stations located in the north of the MCT, which is not observed for the stations to the south of the MCT. The observation of RF data at stations south of HFT suggests presence of extremely low shear wave velocity at the upper most surface of the crust that may be correlated with the thick sedimentary layer present there. However, details about the depth extent of these tectonic features will be clear after modelling the RF data, which is under process.

Nahan Salient

The structural and tectonic-geomorphological data, generated across the Main Boundary Fault (MBF) forming the leading tectonic edge or mountain front of the Nahan salient (Himachal Himalaya), were analysed. Across the north-western limb of the Nahan salient, two new transverse thrust faults, oriented parallel to the direction of propagation of the Himalayan thrust sheet, were recognised. It is revealed that a physiographic front of 4 x 5 km is bounded by these faults along its north-western and south-eastern margins. These faults have uplifted the Dharamsala rocks named as the *Nalagarh lobe* within the Pinjaur dun. In front of the lobe, thrust-fault-splays (splay-1 and splay-2) and associated tectonic fabrics are observed within the Late Pleistocene Quaternary fan deposit. A fresh looking 15 m high hanging wall or wedge top forms the uplifted and rejuvenated bedrock fault-scarp of the MBF. Geometry of the overturned limb of tight to isoclinal fault propagation fold (Fig. 6), formed on splay-2 plane, suggests that the fold is a normal drag, and its development is attributed to the intermittent fault-slips along splay-2. The displacement along splay-2 has offset the marker bed by nearly 1m in which some clasts are rotated parallel to the traces of brittle axial planes of fold. The variable fold geometry and style of deformation are observed along the length of thrust splays. Marking the northern margin of the intermontane piggy-back basin of Pinjaur dun, the MBF is interpreted to be an out-of-sequence thrust that has brought up the Lower Tertiary Dharamsala rocks over the Late Pleistocene fan deposit.

It is inferred that the earlier described lateral ramp on the Main Himalayan Thrust or on detachment does not exist beneath the apex and beneath the south-eastern limb of Nahan salient, otherwise the present symmetrical-shaped salient lying over the so-called

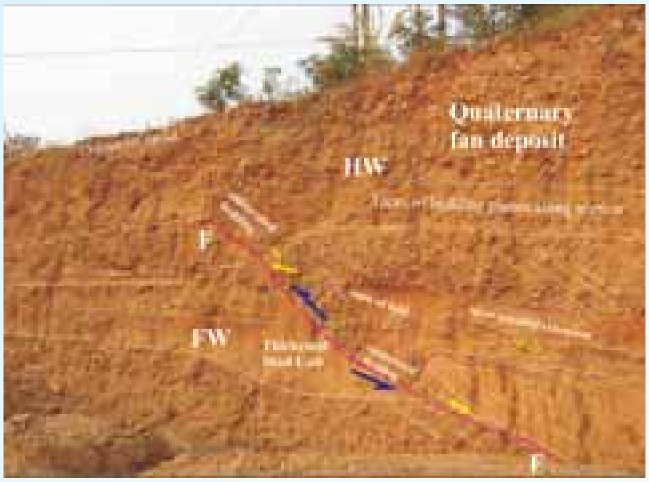

Fig. 6: Fault propagation fold in the Quaternary fan deposit, Nalagarh.

lateral ramp would had been asymmetrical. The fault-slip along the moderately-dipping MBF has transferred to the younger surfaced thrust-fault splays and to the blind thrust-fault splays along which much of the recent tectonic activity is distributed in front of the MBF or beneath the Nalagarh town, Himachal Himalaya.

TAT - 1.2

Present day Uplift or Subsidence and Gravitational Potential energy change in NW-Himalaya and the NE Himalayan Syntaxis: Crust-mantle density in-homogeneity using Satellite Geodesy/Gravimetry and Seismology

(S. Rajesh, Sushil Kumar and V. Sriram)

The present day tectonic activity of the Himalayan Frontal Thrust is the topic that evinces greater interest for geodesists and city planners in terms of its likely seismic potential and consequent natural hazard. We have been monitoring the Frontal Thrust systems and other allied major thrusts in the Dehradun and Kangra re-entrants in the Northwest Himalaya through continuous and campaign GPS network and processed the data by constraining with thirteen IGS stations in ITRF08 reference frame. The results show that the present day velocity vectors in the Kangra re-entrant is towards NNW-SSE with respect to the stable Eurasia; however, for the case of Dehradun re-entrant, it is NNE-SSW. In general, the directions of velocity vectors in both regions have not changed appreciably and are in conformity with the earlier results. With respect to the India reference frame, the GPS velocity vectors are oriented towards southwest in the case of Kangra network, while for the Dehradun network it is towards southeast. Although feeble, but the magnitude of these overriding of thrusts are relatively larger for the case of former with respect to the latter region. At the frontal part, southward movement of the thrust is appreciably less, and this has been earlier attributed due to the presence of subsurface north-south oriented transverse ridges and lineaments. However, the presence of such transverse ridges and lineaments were so far not substantiated with appropriate shallow subsurface geophysical observations. The processing of around 200 shallow sub-surface seismic data reveals the thickness variation of soft soil sediments in the Dehradun re-entrant area. The integrated results aided with gravity data establish the N-S continuation of Delhi-Haridwar Ridge (DHR) and Mahendragarh-Dehrdun lineaments as subsurface systems beneath HFT and probably towards MBT. The occurrence of low magnitude earthquake events at the southern region of DHR system also substantiates the plausibility of Ridge-Thrust collision beneath the southern frontal systems. The change in gravitational potential energy at the thrust zone using topography data is also being investigated. As the part of processing GPS data, the existing processing engine GAMIT has been updated and a few shell scripts were developed to pre-process the data from different station locations.

Seismic Vulnerability Index (SVI), Dynamical shear strain and liquefaction potential in the Dehradun Valley

Shallow seismic investigations carried out in the Dehradun valley has helped to map the shallow soft soil sediment thicknesses. Results on the analysis of ambient seismic noise in the Dehradun re-entrant suggest the existence of variable fundamental frequencies and hence different levels of amplification factor due to variable soft soil thicknesses. The Doon valley consists of ~ 10 to 600 m thick soft soil and its site characteristics are determined by two prominent surface dynamic processes, viz. (i) the fluvial deposition and erosional characteristics by major rivers respectively in their flood plains and river axial valleys, and (ii) the topographic slope instability induced erosion and subsequent deposition at the tectonic boundary close to the base of MBT. For the first case, the dynamical shear strain of soft soil, which is a measure of soil plasticity under short (225 yr) and long term (2500 yr) strong motion conditions are 15 and 25 millistrains, respectively. This is higher than the soil plasticity limit that lead to liquefaction, and hence the valley, in general, has the liquefaction potential. Isolated plumes of large ground deformation of more than 100 cm high soil thickness, high dynamical shear strain of 100 and 200 millistrains, large Seismic Vulnerability Index

(SVI) of 850 and high soil amplification factor (around 12) are observed at the inner flood plains of Dharmawala and the depositional regimes of Yamuna and Asan rivers. These locations have been identified as hazardously vulnerable for liquefaction.

TAT - 1.3
Tectonics of the Shillong Plateau, northeastern India

(Swapnamita C. Vaideswaran)

The Shillong Plateau is bounded by the Dauki Fault in the south, the Himalayan Orogenic Belt in the north, the Kopili Fault in the east and the Dhubri Fault in the west. Beyond the Dhubri Fault lies the Bengal Graben further to the south. The Dauki Fault which runs along the southern border of India between the Shillong Plateau and the Sylhet Basin of Bangladesh, marks a spectacular topographic discordance in the region. This region exhibits several geomorphic signatures representing a tectonically active landform. Considering the tectonic configuration, it is expected that the drainage basins should respond to the cumulative expression of the tectonic activity in the plateau. Four drainage basins were selected for GIS based morphometric analysis which drain towards the southern boundary across the Dauki Fault, namely, (i) Lubha River Basin, (ii) Umngot River Basin, (iii) Jadukata River Basin, and (iv) Simsang River Basin. Morphometric indices suggest that the part of the plateau under study is undergoing crustal deformation and incision and uplift seem to be in equilibrium. Hypsometric curves indicate very young topography for these river basins which is still undergoing uplift. Higher rates of bedrock erosion are observed towards the periphery of the plateau due to enhanced surface uplift and juvenile nature of the central part. Overall, the central part of the plateau shows more uplift than the marginal parts. Dating of the river terraces in this region is in process.

TAT - 1.4a
Tectonic evolution of Shyok Suture and Karakoram Fault Zone rocks and their bearing on Tibet uplift

(Koushik Sen and Barun K. Mukherjee)

Characterization of crustally derived granite, if any, within the Ladakh Batholith and its possible bearing on Indo-Eurasian collision has remained a matter of debate. Evidence of any S-type magmatism and/or remobilization within the Ladakh Batholith which can be used to infer cessation of oceanic subduction and on-set of continental collision has been few and far between. In this regard, the detailed fieldwork and laboratory analysis on a hitherto unknown migmatitic body within the Ladakh Batholith near Upshi and the nearby suite of two-mica granite have been carried out. The field observations suggest remobilization and generation of leucocratic melt within this anatectic part of the Ladakh Batholith. Sen et al. (2014) shown ~65 Ma old I-type granites of the Ladakh Batholith getting migmatized and generating partial melts from ~55 Ma to ~13 Ma in the Karakoram Zone. Sen & Collins (2012) reported presence of a two-mica granite suite within the Ladakh Batholith at Likche having a crystallization age of ~35 Ma. Detailed geochemical analysis is also carried out on the two-mica granite and has been compared with that of the other Paleozoic two-mica granites, e.g. Polokongka la Granite, Mata Granite, Rupshu Granite etc. The comparison suggests genetic relationship between the Paleozoic S-type granites of trans-Himalaya with the two-mica granite of Likche. Petrographic and geochemical studies further indicate that the Chumathang Leucogranite is indeed I-type. Based on the study and published geochemical and geochronological data from various crystallines present in this region, we suggest that the anatexis of the Ladakh Batholith occurred due to Indo-Eurasian collision at ~55 Ma and the ~35 Ma S-type granite magmatism is a result of post-collisional thickening. Some additional isotopic studies will help us constrain our hypothesis even further.

TAT 1.4b
Fluid evolution and formation condition of Migmatites of Karakoram region as well as of Ophiolitic rocks of western Ladakh

(H. K. Sachan and Santosh K. Rai)

The preliminary petrological studies were carried out on the blueschist occurrence in the Shergol ophiolitic mélange, which outcrops over a distance of 250 km along the ITS and consists of several thrust slices sandwiched between the Nindam-Naktul-Dras nappe to the north, and the Lamayuru nappe to the south. Blueschist lithologies are generally heterogeneous and are dominated by volcanoclastic sequences rich in mafic material with subordinate interbedding of metasediments. West of the village of Tringdo, blueschist facies metasediments are generally abundant and suitable for detail petrological studies. They show typical Lawsonite-blueschist (LBS) facies assemblage qtz+phe+lws+Na-amp+grt. Lawsonite and strongly zoned garnet porphyroblasts over grow the main foliation defined by high-celadonite phengite (Si >3.80 a.p.f.u.). Preliminary petrologic results obtained from pseudosection calculations in the

MnNKCFMASH model system constrain peak-P-T conditions to about 380-420°C, 20-21 kbar, *i.e.* at significantly higher P than previously estimated. The following exhumation still occurred in the LBS-facies field, allowing the preservation of lawsonite. The reconstructed P-T evolution suggests that the Shergol blueschists are the result of cold subduction along a thermal gradient of ca. 5-6°C/km, and that such a low geothermal gradient was followed also during exhumation. This P-T evolution is consistent with a mature subduction zone system in an intra-oceanic subduction setting.

For the first time, the occurrence of albitite rock has been observed in Indian Himalaya from the Nubra valley along the Karakorum thrust zone. The location of the rock is near the Wish pond near to Panamik village. The albitites occur as small intrusions associated with widespread alteration of the surrounding country rocks. It is a leucocratic, pale yellow to white or light grey, fine- to medium-grained rock. It is mainly comprised of about 95-97% albite, and 3-5% quartz. This has very well been confirmed by XRD studies and their mineral composition has also been reconfirmed by EPMA. Accessory minerals are zircon, sphene, apatite, biotite, and iron oxides, whereas secondary minerals include chlorite, muscovite and actinolite.

TAT - 1.5
Crustal evolution processes in the Proterozoic Lesser Himalayan domain of NW Himalaya

(Sumit K. Ghosh and R. Islam)

Stratigraphic arrangement within the Lesser Himalaya is convoluted and therefore the correlation or the relationship aspect of the Proterozoic successions of Outer Lesser Himalaya (OLH) and Inner Lesser Himalaya (ILH) is one of the most complicated issues. Near absence of consistent radiometric age data for these sedimentary succession deposited during this particular time-span has made the stratigraphic relationship aspect highly speculative. The main debate is on whether the OLH and ILH sequences are of the same age or are of different age i.e. siliciclastic litho-sequences of OLH, is younger than ILH, separated by a tectonic plane. The correlation primarily based on the comparison of stratigraphic, sedimentologic and petrographic parameters for the Palaeo- and Neoproterozoic litho-units of the Garhwal-Kumaun Lesser Himalaya.

Relationship based on geological set up

The Nagthat Formation of Jaunsar Group of the OLH have been assigned early Neoproterozoic as its stratigraphic position lies below the 692 Ma diamictite and cap-carbonate of the Blaini Formation by a regional unconformity and distinct absence of 1.8 Ga penecontemporaneous mafic volcanics, common in the ILH. A new demarcating line separating between OLH and ILH is proposed and accordingly, the pre-Blaini sedimentary succession of OLH represents younger (Neoproterozoic) and ILH older (Palaeoproterozoic-Mesoproterozoic) part of the Garhwal-Kumaun Lesser Himalaya. The Lesser Himalayan Proterozoic succession appears to be similar to the rift-controlled basinal setting of the Aravalli, Dharwar and other early to middle Proterozoic basins of Peninsular India.

Relationship based on lithofacies patterns

The Proterozoic siliciclastic (SLC) sedimentary packages of the Garhwal-Kumaun Lesser Himalaya reveal the presence of abundant mixed medium and fine facies, common fine, and less common coarser facies. Amongst all these facies, the near shore shallow marine IMFS (interbedded medium fine siliciclastic) facies shows its presence in both Palaeoproterozoic Damtha and Neoproterozic Jaunsar groups of the ILH and OLH zones, respectively. Remarkably, the penecontemporaneous basic volcanics (1.8 Ga) are associated with IMFS of ILH. The presence of Coarse Grained Siliciclastic (alluvial fan) though patchy butit has abundant presence along the Tons Thrust, possibly hint towards a region of rifted basin between OLH and ILH. The gradual stratigraphic upward shift from argillite to siliciclastic and sub-aerially erupted volcanics-dominated sequence as well as the occurrence of several gravel beds in the form of rift related alluvial fan favours gradual shallowing of unstable basin. Taking into account of the east-west lateral facies variations in Palaeo- and Neo-proterozoic succession of ILH and OLH, the muddy facies is relatively high in both the ends, whereas the central portion of the east-west lateral profile is relatively sandier. From the facies distribution pattern, nearly a northwest-southeasterly trending nearly analogous palaeo-shoreline has been envisaged.

Relationship based on detrital modes

Comparing the detrital modes of both the zones, ILH siliciclastics are rich in feldspar and compositionally sub mature, while the OLH siliciclastics are relatively rich in rock fragments. The presence and survival of the labile components like plagioclase feldspar, phyllites and schists indicative of less weathering and short distance of transport. This clearly indicates detrital derivation from nearly similar source area comprising of metasedimentary and gneissic rocks. The study points out that the source areas unroofing remains unchanged from at least between Late Paleoproterozoic (ILH) till Early Neoproterozoic (OLH).

Palaeobasinal history: The Lesser Himalayan litho-succession may be looked in two phases with peninsular counterpart as, (i) Palaeoproterozoic-Mesoproterozoic ILH with Aravalli-Delhi System, and (ii) Neoproterozoic OLH with Vindhyan System. The Lesser Himalayan Gneissic Basement, underwent rapid uplift and fast erosion soon after the Precambrian orogeny, i.e. the compressional regime soon changed to the extensional (much similar to the Himalayan situation), and caused development of rift-related Lesser Himalayan basin. The seismites in the Lesser Himalayan sediments, hint towards highly sensitive crustal conditions in response to 1.8 Ga rift related mafic magmatism. During rifting, possibly the Columbian super-continent after 1.8 Ga, and subsequent to the opening of a basin, the sag of basement in the northern part of the Indian craton also developed and provided accommodation space leading to the deposition of the basinward prograding coarsening upward argillite-siliciclastic shallow marine Lesser Himalayan sediments.

TAT - 1.6

Metamorphism, Migmatization and Magmatism in Higher Himalayan Crystalline: Geochemical and Geochronological constrain on Leucogranite Granite melt generation and emplacement

(P.K. Mukherjee)

A comprehensive model for generation of Higher Himalayan crystalline (HHC) leucogranite magma from psammetic gneiss and orthogneisses have been worked out using trace and REE geochemistry of the migmatite from Dhauliganga section. This has considerably enhanced our understanding about the crustal melting processes and Higher Himalayan Leucogranite. Textural and mineralogical characteristics of migmatites together with the high Sr/Rb ratio and positive Eu anomaly in leucosome, collectively point towards incorporation of plagioclase into the melt fraction along with alkali feldspars and quartz. Further, absence of primary muscovite and stable biotite precludes mid-crustal melting through any dehydration reaction. In contrast to the generally accepted muscovite dehydration melting in migmatites, the orthogneissic migmatites represents H_2O deficient melting at high temperatures, which is capable of generating such leucosome chemistry with positive Eu anomaly and high Sr/Rb ratio. Incorporation of Sr in leucosome is suggestive of increasing percentage of melting through participation of Ca-plagioclase in melting reaction. Fresh euhedral allanite as peritectic phase at the expense of probably monazite caused greater mobilization of LREEs compared to HREEs producing LREE depleted mirror image REE pattern.

Internal structures of the zircon grains from HHC often show very complexly zoning pattern as revealed from their Cathodoluminescence (CL) images. In most of the grains there are at least two distinct zones and occasionally up to three zones of zircon re-crystallization can be recognized. The mantle and the rims are much brighter often yellowish CL, representing grain coarsening by metamorphic crustal re-crystallization, while the low CL darker core represent inherit igneous origin (Figs. 7 and 8). Compared to the core, the thicknesses of the metamorphic rims are more voluminous, which is suggestive of zircon re-crystallization in presence of Zr saturated melt at high temperatures. Also, the protolith igneous core is sometimes completely modified by the later recrystallization.

Fig. 7: Cathodoluminescence (CL) images revealing the internal structures of the zircons from HHC migmatites. Low CL dark core is inherent igneous zircon which is overgrown by bright or pale yellow metamorphic rim.

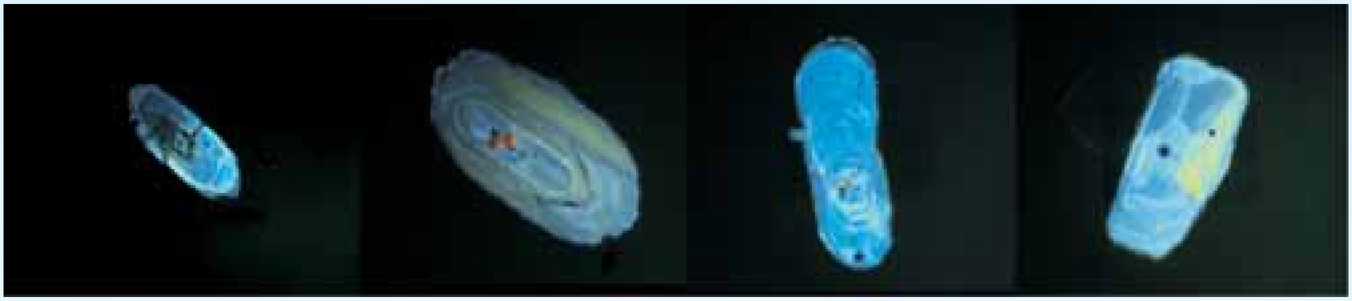

Fig. 8: Complex compositional zoning pattern in zircons from the migmatite zones. Patchy yellowish CL is due to incorporation of P and LREEs as activators probably suggest fluid assisted transgressive recrystallization.

TAT - 1.7

Tectono-metamorphic evolution of Higher Himalayan Crystallines: Perspective of channel flow Models

(Keser Singh and T.N. Jowhar)

The extrusion of the HHC, in the northwest of Beas valley, NW Himalaya has been worked out. The geological set-up of the area is in contrasts to the normal geological set-up i.e. the Tethyan rocks occur to the south of the HHC and their leading edge is in contact with the Lesser Himalayan rocks. The failure to distinguish the tectonic break between the inverted and the prograde metamorphic sequence in the HHC, and how the MCT exhumed again along the Kishtwar Window cropped-out as a domal structure within the HHC made this area different from other parts of the Himalaya. The Zanskar Shear Zone (ZSZ) is exposed further north of the HHC. This distinctive set-up is documented around areas of Chamba, Kishtwar and Zanskar regions in the northwest Himalaya. Structural studies have been carried-out to understand the contact relationship between the southerly placed Tethyan rocks and the HHC, and extrusion mechanism of the HHC. The summary of the prominent structural features of this sector are (i) the MCT has been more or less concealed below the Tethyan rocks except in the Chenab valley where it is exposed in a limited areas, south of the window, (ii) the metamorphic isograds within the HHC were folded as a consequence of development of a relatively younger thrust i.e. the Kishtwar Thrust (KT), (iii) the KT in-turn, thus differentiated the HHC lying south of the KW as its klippe and the portion placed north of this window as its root zone, and (iv) the curvature in the MCT concordant to the doming of the KW is consequence of the movement along the KT, which in turn, indicate the movement activity now, controlled by the KT and cessations of tectonic activity along the MCT. This thrust now act as basal thrust plane, while the ZSZ as roof (extensional fault) tectonic plane for the extrusion of the HHC in this part of the NW Himalaya. Structurally up-section, the tectonic position of the Tethyan rocks now exposed as the Chamba succession south of the HHC is the outcome of the relatively faster and earliest translation of the Tethyan rocks along the Chamba Thrust concurrent with the translation of the MCT.

In addition, the homogenization studies on the well-ordered alkali feldspars (intermediate to maximum microcline) from various granitic bodies from the Northwestern Himalaya were also carried out. Four granitic bodies of different ages with varying geographic locations in space and time were investigated for experimental study. These are: Precambrian Granite (Kumaun Himalaya), Upper Proterozoic Granite (Garhwal Himalaya), Palaeozoic Mandi-Karsog Granite (Himachal Himalaya) and Tertiary Granite (Garhwal Himalaya). These granitic bodies have suffered regional metamorphism and the deformation episodes during the Himalayan Orogeny and consequently developed contact aureole zones. The homogenization of alkali feldspars was carried at high temperature (1050$\pm$2°C) and at atmospheric pressure. The results indicate that the melt temperature of Amritpur and Badrinath granites does not show a wider variation in the melt temperatures (705-750°C), but the Naini and Dhauladhar Range Mandi-Karsog granites show a wider variation in the melt temperatures (720-835°C). The variation could be due to the large size of the bodies as well as varied source material and fluids present. It is concluded that the homogenization studies on the alkali feldpars had given a melt temperature of 705 to 750°C for the Amritpur Granite, 720 to 818°C for the Naini Granites, 725 to 835°C for the Dhauladhar Range Mandi- Karsog Granites and 720 to 750° C for the Badrinath Tertiary leucogranites. The melt temperatures determinations have been used in petrogeneitic modelling of these granite bodies.

TAT - 1.8

Geochemical and crustal evolution of the Himalayan orogenic belt in Himachal NW Himalaya, and in the Eastern Syntaxial Belt, NE India

(S.S. Thakur, A.K. Singh, D.R. Rao and Rajesh Sharma)

NW Himalaya

The amphiboles of the mafic xenoliths from the Sutlej valley, NW Himalaya are studied in the context of mineral chemistry and cation substitution. They are further considered for geochemical study in order to understand their protolith characters. The mafic xenoliths are characterised by the occurrence of hornblende and Mg-Fe-Mn amphibole. The detailed petrography of the latter showed it to be cummingtonite of grunerite variety. Hornblende constitutes the dominant mineral of the mafic xenoliths. It occurs as a well-developed matrix mineral, and as a cleavage-less massive retrograde mineral around clinopyroxene. Mineral chemistry of the hornblendes shows that they are of magneiso-hornblende, ferro-hornblende to ferro-tschermakite varieties. The data plot of hornblendes in Na^{A} vs Al^{VI} and Na^{A} vs Al^{IV} binary diagrams shows that they have undergone both edenite as well as tschermakite substitution. The *P-T* calculation of hornblende based substitution mechanism, shows that the amphiboles of the study area have equilibrated in the temperature range of 550-650ºC and pressure range of 3.0-7.5 kbar.

The geochemistry of mafic xenoliths of Baspa valley is further investigated to characterize their protoliths on the basis of immobile elements, especially trace elements including REE. They occur within the Kinnaur Kailash Granite (KKG) and their geochemistry show that they have tholeiitic nature with basaltic composition. Compositionally, they range from 'depleted' to 'enriched' MORB nature and match with various 'enriched' or 'transitional' MORB types. Their enriched character when compared with N-MORB, E-MORB and OIB rocks on chondrite normalized and primordial mantle plots reveals that it is intermediate to that of E-MORB and OIB. The geochemistry of the rocks suggests that the enriched components are probably derived by melting of a mantle source with an enriched OIB-type component rather than due to the crustal contamination. The geochemistry of the mafic xenoliths emphasize that the rocks are prominently developed in zones of crustal extension or occur at intra-plate hot spots in both oceanic and continental regions, and that they are not volcanic rocks of island arcs related to subduction tectonics.

NE Himalaya Eastern Syntaxial Belt

The Zimithang Thrust in NE India juxtaposes two lithotectonic units of the Greater Himalayan Sequence in Arunachal Pradesh. The timing and conditions of their juxtaposition across the structure, and their subsequent cooling can be constrained from the monazite U-Pb, muscovite $^{40}Ar/^{39}Ar$ and thermo-barometric data of rocks from the hanging and footwall of the thrust. Monazite grains in biotite-sillimanite gneiss in the hanging wall yield LA-ICP-MS U-Pb ages of 16±0.2 to 12.7±0.4 Ma. A schistose gneiss within the high strain zone yields overlapping to younger monazite ages of 14.9±0.3 to 11.5±0.3 Ma. Garnet-staurolite-mica schists in the immediate footwall yield older monazite ages of 27.3±0.6 to 17.1±0.2 Ma. Temperature estimates from Ti-in-biotite and garnet-biotite thermometry suggest similar peak temperatures were achieved in the hanging and footwalls (~525-650°C). Elevated temperatures of ~700°C appear to have reached in the high strain zone, and in the footwall further from the thrust. Single grain fusion $^{40}Ar/^{39}Ar$ muscovite data from samples either side of the thrust yield ages of ~7 Ma, suggesting that movement along the thrust juxtaposed the two units by the time the closure temperature of Ar diffusion in muscovite has reached. These results further confirm that major orogeny parallel out-of-sequence structures disrupt the Greater Himalayan Sequence at different times during Himalayan evolution, and highlights an eastwards-younging trend in $^{40}Ar/^{39}Ar$ muscovite cooling ages at equivalent structural levels along Himalayan strike.

TAT - 1.9

Mineralization and Metallogeny in northwest Himalaya: Emphasis on the role of complex fluids in magmatic and mineralization processes

(Rajesh Sharma)

The chalcopyrite enriched sulphide ores are found in quartzite and associated metavolcanic hosts of Banjar Group in Largi-Banjar area in Himachal Pradesh. Together with disseminated ores, vein filling and breccia filling features are seen. The ore bearing veins show co-folding with the host rocks. The ore petrographic and fluid inclusion study is carried out on sulphide assemblage, and limited sulphur isotope data is obtained. The field features and ore petrography attributes syntectonic remobilization of syngenetic ores. Limited sulphur isotope values of these ores show $\delta^{34}S$‰ between 20 and 22. The records of the hydrothermal fluid are noticeable along the Banjar Thrust wherein the temperature of the ore forming fluids are higher than the mineralized veins present away from the thrust plane. This observation match well with the earlier study of the sulphides from the north Chiplakot thrusts in north east Kumaun Himalaya, India, wherein hydrothermal fluids were active along the thrust plane. The upper range of homogenization temperature obtained and the pre-dominance of aqueous fluid indicate that the fluid involved was hydrothermal. Cavity re-equilibrations of the pre-exhumed inclusions are not prominent.

Some thermal springs neighbouring Chiplakot Crystalline Belt (CCB) of NE Kumaun Himalaya are studied for chemical characterization, estimation of reservoir temperatures and stable isotopic signatures. The chemical studies of the thermal waters of Tapovan, Bhenti, Darr, Shera, Devibagar and Pangla hot water springs from this region attribute that these thermal springs originate from different reservoirs. The water chemistry and $\delta^{18}O$ signatures imply involvement of chemically immature, meteoric water in the formation of hot springs. It is proposed that the hot water springs around CCB are evolved by heating of the percolating meteoric water in high geothermal gradient.

Attempts have also been made to study the fluid inclusions in chromite from the chromitite of Manipur Ophiolitic Complex, Indo-Myanmar Orogenic Belt of NE India. The chromitite is predominantly massive, and sometimes disseminated and rarely granular and nodular types. The study aims to investigate magmatic fluid involved in chromite crystallization, and that released from the mantle. Based on optical observation, morphological peculiarities and spatial distribution, the inclusions are classified as dark monophase filled with gas and those comprising a gas and liquid at room temperature. Aqueous phase is noticeable in some inclusions. The fluid inclusions in chromite indicate separation of complex fluid phase with low water contents from the magma.

TAT - 2: INDIAN MONSOON-TECTONIC INTERACTION AND EXHUMATION OF THE HIMALAYA

TAT - 2.1

Sediment production and sedimentation in Drier Himalaya: Patterns, time scales and palaeoclimatic in trans-inferences

(Pradeep Srivastava and Koushik Sen)

Ladakh lies in the rain shadow zone of Indian Summer Monsoon (ISM) where sand ramps provide a good record of the past aeolian activity in the region. During the year, records from five sand ramps that is based on their sedimentological structure and Optically Stimulated Luminescence (OSL) chronology have been investigated. Sedimentary architecture indicates that the sand ramps of Ladakh are composite records of aeolian, hill slope erosion and fluvio-lacustrine activity (Fig. 9). The OSL chronology suggests that in Ladakh Himalaya aridity and aeolian activity was dominant during 25-17 ka and <12-7 ka. Wetter conditions, as evidenced from interdunal lake formation and fluvial gullying, prevailed at ~12 ka to 7 ka. These dry and wet phases correspond to variations in SW monsoon strength. A sand ramp, at Saboo is studied in detail using mineral susceptibility and clay mineralogy. The environmental magnetic susceptibility shows significant enhancement in fluvial and lacustrine sediments and also shows sharp positive excursion at hiatuses where a hard crust is formed, and confirms warm and wet conditions at ~12 ka and ~7 ka. Clay mineralogy is dominated by illite and shows no changes all through the profile suggesting that sediment generation took place mainly due to physical weathering and that although climate fluctuated between wet and dry (as visible in magnetic mineralogy) threshold climatic fluctuations were never reached so as to alter the clay mineralogy during the Late Pleistocene in Leh valley.

Fig. 9: Sand ramp exposed near Nyoma, Ladakh.

A program on the study of Paleofloods in Ladakh Himalaya has also been initiated. This year a paleoflood record was located and studied at the confluence of the rivers Indus and the Zanskar at Nimu. The deposits, composed of 25 flood couplets of fine sand-clayey silt, sit at ~29 m above the river level. This is twice as high as the last catastrophic flood recorded in the region in the year 2010. The chronology indicates that these floods are clustered around the Holocene monsoon optima between 11-9 ka.

TAT - 2.2

Tectonic vs. Climate change as causal mechanism for beginning of non-marine sedimentation in trans-Himalayan Cenozoic basins

(B.N. Tewari)

Miocene induction of freshwater exotics in the Subcontinent at incipient stage of Himalayan orogeny

Occurrence of exotic genera of freshwater fish, gastropoda and ostracod from Ladakh molasse Group of horizons are in the focus of this endeavor with a purpose to gain insight pertaining to Palaeogeographic conditions that came into being during the depositions of yielding horizons. While mammals of the Ladakh molasse Group assemblage provide regionably constraint temporal control associated exotic faunal element in the assemblage provide us potential clues in reconstructing the Palaeogeographic details indicating that precipitation in the higher reaches of Ladakh batholith and adjoining Tibetan plateau started towards suture zone as early as Miocene. This was a major geoevent with equally significant biotic ramifications.

Miocene Rodentia from Dharmsala Group in Kangra Valley, Himachal Pradesh

While constraining Cenozoic evolution of the Himalaya through enlightening fossils we find that Dharmsala Group (intervening Subathu Group and Siwalik Group) in Kangra Valley and adjoining coevals yield sporadic fossils. Hence, this first record of fossil rodents from

Dharmsala Group is an important addition to an earlier report of dinothere from these horizons. The rodent material from grey facies of the Dharmsala Group comprises an isolated premolar and fragments of a tooth and an incisor. Available crown details in conjunction with distinctive dimensions of the premolar lead to its assignment to Hodsahibia, a baluchimyine taxon; this taxon of Eocene lineage of south Asian-African distribution is already on record from Early Oligocene horizons in Bugti area, Pakistan.

Neogene freshwater gastropods from the Siwalik Group in Uttarakhand

In the Indian western Himalaya, we found freshwater gastropods in siliciclastics beds of the Siwalik Group in the Doon Valley, Uttarakhand. The record of juvenile shells of a freshwater cerithioidean snail (Mollusca, Caenogastropoda) from the Siwalik Group of Mohand area from a horizon dated ~5 Ma (around Mio/Pliocene boundary) is focused on in conjunction with reported similar occurrences from other rather coeval horizons of the Himalaya. An updated account of the occurrences of freshwater cerithioidean snails from the Himalaya in the latest context provides new insights into the evolutionary history of the Asian freshwater cerithioideans.

TAT - 2.3

River response to allogenic forcing and late Quaternary landscape evolution: Punjab re-entrant

(N. Suresh and Rohtash Kumar)

Field work was carried out in the Satluj and Beas rivers to identify fluvial terraces, its distribution pattern, and litho sections measurement. The litho units are dominated by gravel and sand and the architecture and composition of beds were noted. The gravels, in general, are imbricated and poorly sorted and its clast composition is dominated by quartzite (white > pink), limestone, volcanics, granite gneiss, black slate and shale. Further, the samples from representative sandy litho units were collected for grain size, clay mineral studies and optically stimulated luminescence (OSL) dating to establish the chrono-stratigraphy.

In the Satluj River valley, six levels of terraces were identified (Fig. 10A). Litho section measurements were carried out from the selected locations. In the hanging wall of MBT, all the six levels of terraces (T1 to T6) were observed. The lithology of topmost terrace (T6) is very unique and dominated by thick sequence of medium to gritty sandy facies which shows trough cross stratification (Fig. 10B). This terrace is wide and extensively developed, occurs about 340 m from the present river level, and is well preserved at Bali, Aut, Chabba and Ogli areas. Similar thick sandy sequence, in the form of alluvial deposit, is also noted in the outer margin of Sub-Himalaya, near the vicinity of Himalayan Frontal Thrust. The available OSL ages suggest they were deposited between 50 and 70 ka. The subsequent lower terraces are however, dominated by gravel facies. The gravels are clast to matrix supported, poorly sorted, fining upward and imbricated (Fig. 10C) and consist of quartzite, granite gneiss, limestone and slate clasts. The terrace chronology shows they were deposited under different time intervals during late Pleistocene and Holocene. The clay mineral composition of samples was investigated to constrain the clay mineral provenance and distribution pattern. The dominant clay minerals observed are illite and chlorite.

Fig.10: (A) Panoromic view of Sutlej Valley showing flight of fill-terraces near Sunni-Chabba area, south of Main Central Thrust. (B) Thick pile (>50m thick) of medium to very coarse sand, resting over limestone terrain of Lesser Himalaya, representing topmost terrace at Bali, near Tatapani area. Internally it shows trough cross-stratification and parallel lamination. This terrace is observed at several locations along Sutlej River at Aut, Chabba and Ogli areas. (C) clast supported, well organised, poorly sorted and imbricated gravel of T-3 terrace resting over lesser Himalayan limestone.

In the Beas River valley, further field work was carried out between Kullu and Pandoh, Dharampur and Harsi and near Nadun areas. In the Beas valley, four levels of terraces (T1 to T4) were documented between Kullu (H.P.) in the north and Nadun in the south. The topmost terrace is extensively developed between Dharampur and Sandhol. The clasts compositions of these terraces are dominated by quartzite followed by granite gneiss.The sedimentary sequence forming the terraces are comprised of rounded to sub-rounded gravels, resting over Siwalik rocks, and is dipping. The bulk compositions of sandy units are dominated by quartz, feldspar, calcite and clay minerals. Among the clay minerals, illite and chlorite are dominant. The detailed study is under progress.

TAT - 2.4
Late-Quaternary paleomonsoon study in Ladakh, North western Himalaya and Indo-Gangetic plain, India

(Narendra Kumar Meena, Sudipta Sarkar, Anil K. Gupta and M. Prakasam)

The project aims to reconstruct high resolution climate records from the Himalayan region. For this purpose, the coring of three lakes e.g. Renuka, Rewalsar, and Tso-Moriri has been completed. During the year, the age-dating of nine samples from the Tso-Moriri lake core has been done using ^{14}C AMS method. A multi-proxy data set (magnetic susceptibility, grain size, geochemistry, stable isotope of carbon and nitrogen etc.) of Tso-Moriri lake has also been developed. The Rewalsar lake core has been focused to study the high-resolution climate from the mid-altitude Himalaya. The core samples have been dated using ^{14}C AMS dating technique. The geochemical and grain size analysis for this core is under progress. The uppermost two meter core of the Rewalsar lake has been considered for the anthropocene pollution loading assessment in lake and climate lake sediment response study. Therefore, the core sample was dated with ^{210}Pb, ^{310}Cs isotope to get high resolution age constrain. Past ~50 years man made activities form the lake has been reported with help of the geochemical data. The core sample of the Renuka lake is being analyzed for various parameters. The result suggests that the Tso-Moriri Lake experienced a cold and wet climate phase during ca 1650 to1850 AD. This event has an abnormal trend of climate in this dry and cold desert region. The mechanism of this event can be explained by the shift in circulation pattern in the influence of Inter-tropical Conversance Zone (ITCZ) and expansion of tropics. The Rewalsar lake core shows a higher rate of the sedimentation in the lake probably due to hilly surrounding from three sides. The rate of the sedimentation has unprecedentedly increased from last 50 year at the rate of ~4 cm/year. If this rate of the sedimentation continues in this lake then lake will be filled by silt in ~80 years. The historical geochemical data reveals the loading of Pb, Cr, Ni and Co from the domestic waste from nearby Rewalsar town. The Ti variation in the lake indicates the variation of rainfall in the Rewalsar lake and its catchment area. The lake needs immediate remedial measures.

TAT - 2.5
Climate Variability and Treeline Dynamics in Western Himalaya

(P.S. Negi and Jayendra Singh)

In order to understand climate-vegetation variability in historical and modern perspective through palynological investigation and field survey in alpine ecosystem, peat bog samples were collected from the upper catchment of Pinder valley (Fig. 11). The samples have been sent for AMS radiocarbon dating to the National Ocean Sciences Accelerator Mass Spectrometry, Woods Hole Oceanographic Institution, USA. The study for the preparation of pollen graph is continuing.

The spatial dynamics of treeline was also studied as a climate change marker (Fig. 12). The analysis of data retrieved from 26 treeline reference points collected earlier, suggested that treeline dynamics persisted @ 10 m/year in the Chorabari glacier valley and 1.7 m/year in the Dokriani glacier valley since 1962. The sustained upwards shifting of the treeline is mainly attributed to the shrinking snow-ice domain due to change in climatic factors that have become more suitable for tree growth. The species such as *Betula utilis*, *Sorbus acuparia*, *Rhododendron companulatum* etc, were reported frontline invader to the erstwhile snow-ice regime whereas, species like *Quercus semicarpifolia*, *Taxus baccata*, *Abies spectabilis*, *Juuniperus squamata*, *Juuniperus Indica* etc. were the part of dominant floristic compositions. The ever increasing forest area has changed the landuse system that is likely to affect various ecological and geo-hydrological cycle in alpine ecosystems.

In order to understand the climate history, February-June mean temperature was reconstructed extending back to AD 1455 using three site ring-width chronologies of *Cedrus deodara* from the Tons valley, western Himalaya (Fig. 13). A 30-year running mean calculated over the reconstructed series showed that

Fig. 11: Peatbog trench showing layers of deposition during historical time.

Fig. 12: Treeline dynamics as a climate change marker.

both the coolest (AD 1911-1940) and the warmest (AD 1941-1970) periods occurred in the 20thcentury in the last 548 years. Sixteen tree cores of *Picea smithiana* from Tela camp, Dokriani glacier, Dingad valley were processed, dated and measured with an accuracy of 0.001 mm. Ring-width chronology using *Picea*

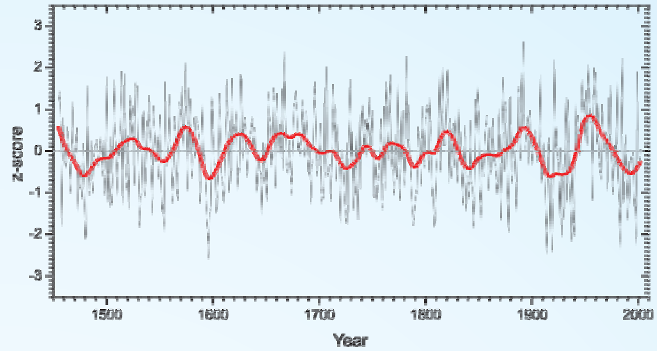

Fig. 13: February-June mean temperature reconstruction, bold line is 30 year low pass filter.

smithiana samples was developed extending back to AD 1656. Sixteen additional tree cores of deciduous species from the same site are also being processed in the lab for dendroclimatic studies. Tree core samples collected from the Bhagirathi valley and Chorabari glacier valley are being processed for further dendroclimatic analysis. Twenty tree cores have been processed for further dating and ring-width measurement.

TAT - 2.6

Geochemical and isotopic studies as tracers of weathering and erosion processes in the NW Himalaya

(Santosh K. Rai, S.K. Bartarya, Anil K. Gupta and A.K.L. Asthana)

The uplift of the Himalaya in contributing to enhanced silicate weathering, and is the subject of investigation. Among the Himalayan Rivers, the Indus-Ganga-Brahmaputra (I-G-B) system has been studied for chemical weathering in great detail. As these rivers have very high water discharge, they serve as a major pathway for transporting the weathering products from the Himalaya to the oceans. Present work is focused on the nature of the weathering in the Indus River system covering its drainage in Ladakh region and is based on the major ions and stable isotopes ($^{13}C_{DIC}$) in dissolved phase. Silicate weathering is a key process in Indus River catchment which has implication on the global CO_2 budget.

This process operates as follows:

Silicate weathering (1):

$$CaSiO_3 + \downarrow 2CO_2 + 3H_2O \rightarrow Ca^{+2} + 2HCO_3^- + H_4SiO_4$$

Carbonate weathering (2):

$$CaCO_3 + \downarrow CO_2 + H_2O \rightarrow Ca^{+2} + 2HCO_3^-$$

Carbonate (in oceans) (3):
$Ca^{+2} + 2HCO_3^- \rightarrow CaCO_3 + \uparrow CO_2 + H_2O$

Net (1 & 3) effect (~1 My time scale):
$CaSiO_3 + \downarrow CO_2 \rightarrow CaCO_3 + SiO_2$

$\rightarrow$ CO_2 mediated Silicate weathering is a sink of CO_2 $\rightarrow$ Cooling effect

Other possibility: Sulphuric acid mediated (Black Shales & Pyrites) Silicate weathering:

$4FeS_2 + 15O_2 + 8H_2O \rightarrow 2Fe_2O_3 + 8H_2SO_4$;

$H_2SO_4 + 9H_2O + 2NaAlSi_3O_8 \rightarrow Al_2Si_2O_5(OH)_4 + 2Na^+ + 2SO_4^{2-} + 4H_4SiO_4$ $\rightarrow$ No CO_2 is consumed $\rightarrow$ No net effect on climate on longer time scale.

The results of the stable isotopes ($^{13}C_{VPDB}$ range 0.4 to -5.7‰) and silica (73 to 280μ E) generally agree with the earlier studies (Fig. 14). The variation of $^{13}C_{VPDB}$ measured in Dissolved Inorganic Carbon (DIC) with concentration of SiO_2 in Indus River waters shows that the alkalinity in these rivers is linked with silicate weathering. However, co-variation of $[HCO_3+SO_4]$ with [Ca+Mg] indicates that the alkalinity in these rivers may be linked with silicate weathering mediated by H_2SO_4 or dissolution of halites. Therefore, the silicate weathering seems to serve as a dominant mechanism to produce the alkalinity in these rivers. This observation is also supported by the fact that the silicates (granites, gneisses, schists etc) in the Indus valley comprise mainly of minerals including quartz, plagioclase, alkali feldspar, biotite and muscovite and dissolution of these can produce silica and alkalinity together in solution. The possibility of pronounced silicate weathering in the Indus river system also finds support from the fact that it is flowing through the Indo-Tsangpo Suture zone with a high tectonic activity and highly fractured/sheared rocks which are prone to weathering. This work provides a testing tool for the nature of silicate weathering in the Indus catchment.

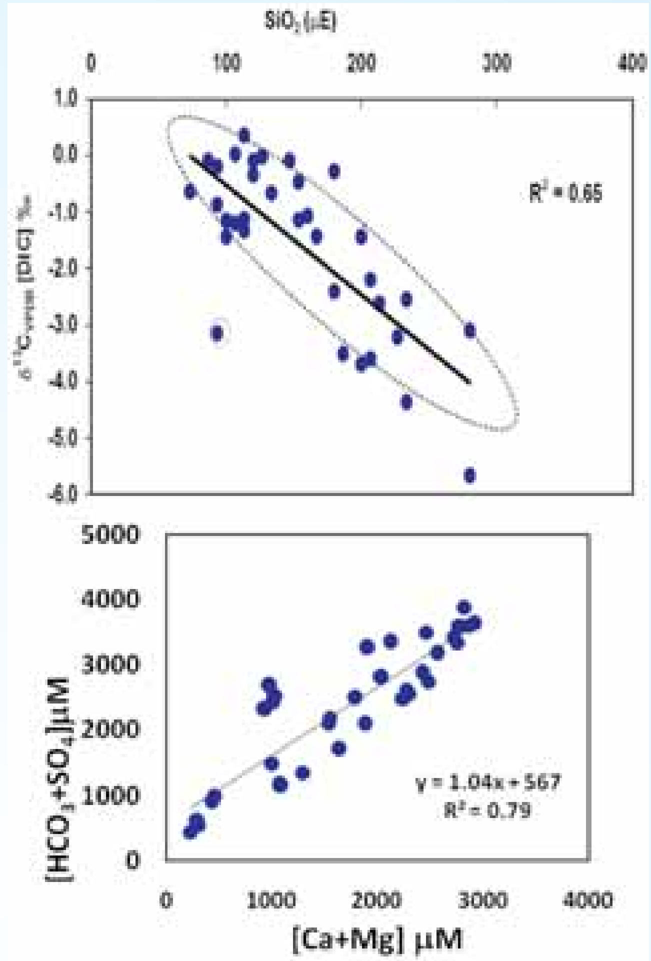

Fig. 14: Hydrochemistry of Indus River system (Ladakh).

Studies were also carried out to understand the landform development of the Ramganga basin covering the Garhwal Himalaya. The drainage parameters (linear, areal and relief) of the basin from Dudhatolidhar peak (its origin point) to Kalagarh where it enters into the plain were measured. The impact of the morphological characters on the terrain is reflected by the drainage basin of the area. The calculated values of all the morphometric parameter of 38 (5^{th} order) intra-basins for different lithotectonic units were computed under four sectors viz., NE of North Almora Thrust (NAT), between NAT and South Almora Thrust (SAT), between SAT and MBT and downstream of MBT. In the lower reaches of the Ramganga Basin, the morphometric parameters show the existence of proportionality between stream length and catchment area which is not seen in the crystalline zone. Structural control on the drainage patterns of the Ramganga river and its tributaries are observed in the form of straight course, wide valleys with thick fluvial deposits and with relatively gentle stream gradient along the transverse faults to incised valleys, less fluvial deposits in the banks and steeper stream gradient with knick points in the hanging wall of the thrusts.

This basin is traversed by a numbers of regional and local structural discontinuities such as NAT, SAT, Bono-Bhikiyasain-Naurar Fault (BBNF), Ramgarh Thrust (RT) and MBT. In order to understand the implications of these faults, drainage basin-symmetry indices have been implored upon the drainage network. Streams having higher order streams (>5^{th} order) have been considered for analysing the transverse topographic symmetry (T) and a total of 250 T values have been obtained. T values range from 0 to 0.88 with an average value of 0.376 with mean bearing towards 192°.

TAT - 2.7
High resolution Paleoclimate records from the Himalaya and adjoining regions

(Anil K. Gupta, Jayendra Singh and Santosh K. Rai)

Mean late summer (July-August-September) temperature reconstruction (Fig. 15) extending back to AD 1852 was developed for Sikkim, northeast India using ring-width chronology of Larch (*Larix griffithiana*). The reconstructed mean JAS temperature shows warming since 1930s, with 1996-2005 being the warmest in context of the past ~150 years. 982 years long spring (March-April-May) precipitation was also reconstructed from Kinnaur region, Himachal Pradesh. Field work was also carried out in the month of September-October for 26 days and collected 180 tree cores from 115 trees of three different species from Kinnaur, Himachal Pradesh. 30 tree cores of *Pinus wallichiana* collected from three sites in Kinnaur region were processed in lab and each growth ring dated to the level of calendar year of its formation. Ring-width of each growth ring was measured with an accuracy of 0.001 mm, ring-width chronology preparation is in process. Tree ring samples collected from Shillong area are also being processed for further climate change studies.

Lacustrine deposits from Tso Moriri Lake, Ladakh and speleothem carbonates from Meghalaya were examined to understand changes in the Indian summer monsoon since the MIS3. The speleothem record shows a weak summer monsoon during the Last Glacial Maximum and the Younger Dryas and strong monsoon during 10,000-6,500 cal yrs BP. The record shows a strong 1700 yrs cycle in monsoon variability.

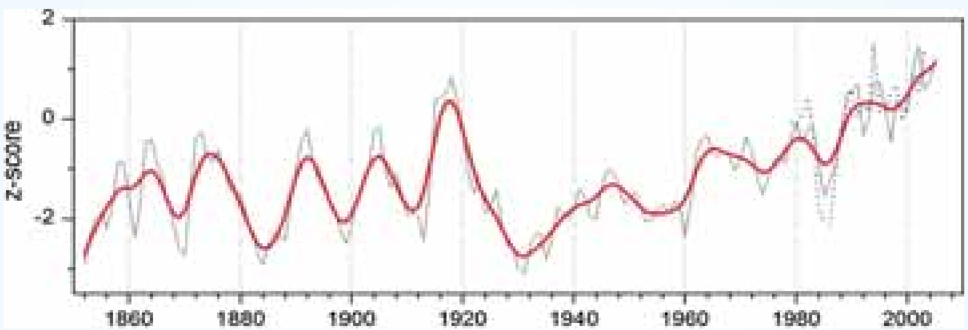

Fig. 15: Mean late summer (July-August-September) temperature reconstruction for Sikkim, eastern Himalaya. Thick line is 10-year low pass filtered version.

TAT - 2: INDIAN MONSOON-TECTONIC INTERACTION AND EXHUMATION OF THE HIMALAYA

TAT - 3: EARTHQUAKE PRECURSORS STUDIES AND GEOHAZARD EVALUATION

TAT - 3.1

Seismological, seismotectonic and subsurface related studies seismic hazard evaluation from the Ladakh, Kinnaur, Kangra and Garhwal-Kumaun regions of the NW Himalaya

(Sushil Kumar, Ajay Paul, Dilip Kumar Yadav and Devajit Hazarika)

During the year, earthquake data has been collected from seismic stations of Kangra, Garhwal, Himachal, and Ladakh network, and used for different seismological studies such as source mechanism study, stress and strain analysis in the Himalaya. Around 41 Broad Band seismographs in the NW Himalaya along with other geophysical equipments are in operation. The data is being acquired and analysed continuously by the networks. During the period of reporting, a total of 5965 events have been detected which includes 962 local events (Fig. 16), 2331 regional events, and 2672 teleseismic events. The space time pattern are regularly being examined to demarcate the zones of enhanced/quiescence that invariably precede the large earthquakes in this region.

One dimensional crustal velocity model for Himachal Pradesh

The preliminary 1D velocity model for Himachal Pradesh, India has been obtained by utilizing the travel-time inversion of P and S phases of the seismic waves. For this seismic data of 22 (3-component) broadband seismometers having a sampling rate of 100 samples installed in this region from 2004 to 2013 were used. A total of 476 local seismic events (Fig. 17) having their epicentres within the NW Himalaya with more than six P and S phases were located initially with the HYPO 71 and the priori velocity model. Of these 476 seismic events, 125 events with maximum RMS of 0.40 s were used for travel-time inversion. It has been observed that the RMS residual is almost constant at 0.03. This shows that the iteration has reached its final solution and the

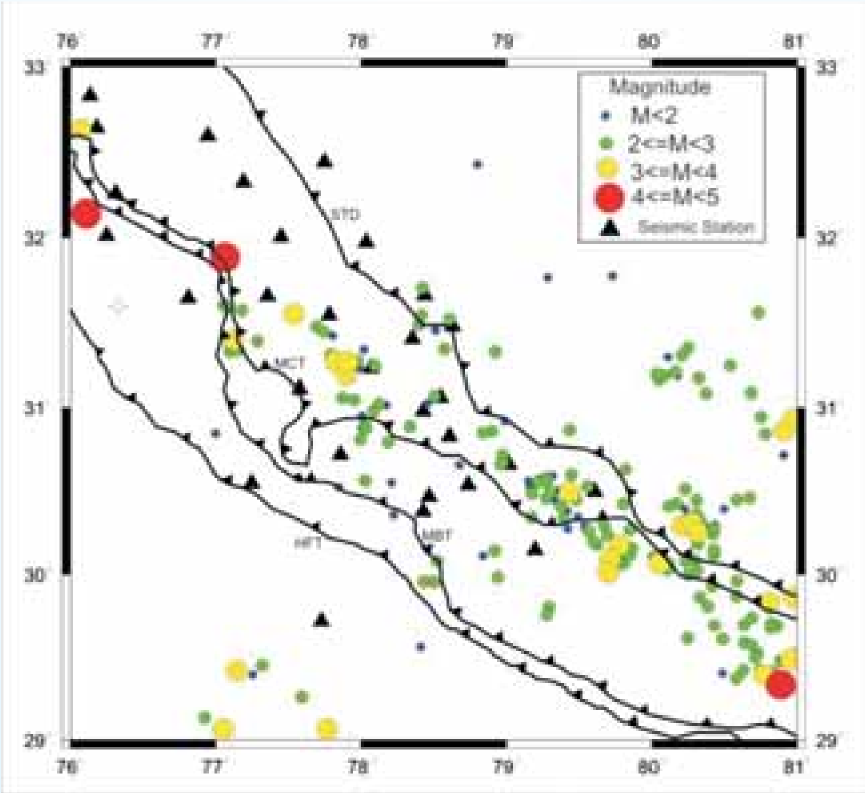

Fig. 16: In this figure Seismic stations and Local events recorded during April 2014 and March 2015 are shown.

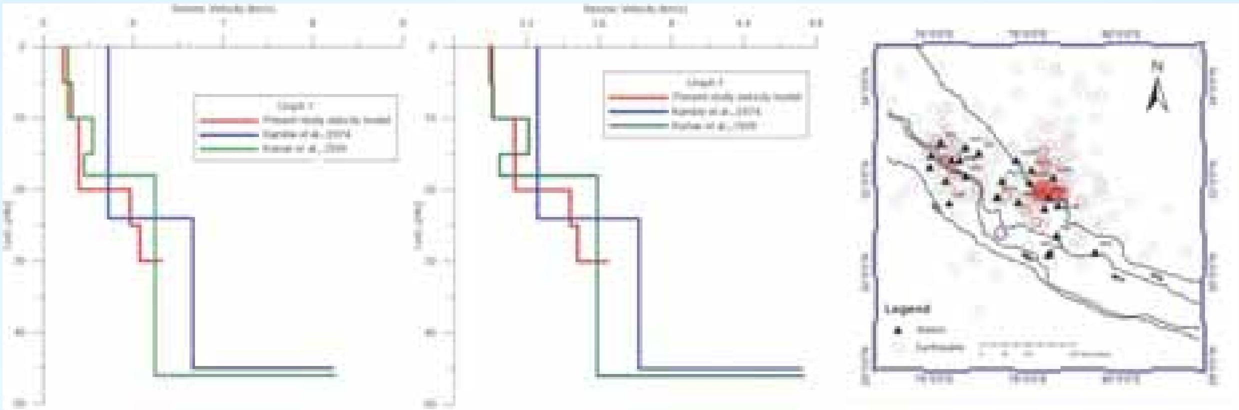

Fig. 17. Total of 476 local seismic events used for the determination of 1D crustal velocity model are shown. The final 1D crustal P & S Velocity models for Himachal Pradesh have also been plotted.

velocity model obtained is the minimum one dimensional velocity model with least RMS residual. The resulting relocation shows a maximum seismicity upto a depth of 30 km which matched with the ongoing tectonic activity in the region. Later the JHD technique is applied taking the station corrections into account for testing the accuracy of the model (Fig. 18). The error in hypocentre location has reduced to ±1 km which confirms the accuracy and stability of the proposed 1 D model.

In the present study, 166 events have been relocated using HypoDD. These events triggered in the Kinnaur region of Northern Himalaya, India. The local magnitudes of these events are in range between 2 and 4 and focal depth from 2 to 60 km and were recorded during 2010-2013 at the WIHG seismic network consisting of 8 digital broadband 3-components seismographs. Total 4495 P and 4453 S arrival times of 166 earthquakes (Fig. 18) recorded in the region have been utilized. The results indicate majority of the events are confined along the Kaurik-Chango fault, a causative fault for the moderate 1975 Kinnaur earthquake (Mb 6.8) triggered in the Kinnaur region.

The micro-earthquakes of this region are primarily shallow focus having low stress drop values and dominantly of thrust mechanism. Analysis of P-wave spectra yields seismic moments for the local earthquakes in the range of 2.40×10^{11} to 4.23×10^{14} Nm and most of them show low stress drop values. The locations and characteristics of seismicity reveal that the region above the detachment continues to release energy in the form of smaller magnitude earthquakes while the strain is continuously accumulating at the ramp or the zone below the plane of detachment. In this region the accumulated strain energy is enough to generate a great earthquake. The focal depths of the four great earthquakes in Himalaya lies below the Main Himalayan Thrust (MHT). Keeping this in view it is suggested that the probable source zone for a great earthquake in the Central Seismic Gap (CSG) would be below the MHT.

Repeating earthquake sequence in the Garhwal region

A repeating earthquake sequence in Garhwal region, which occurred between the depth range of 40-55 km

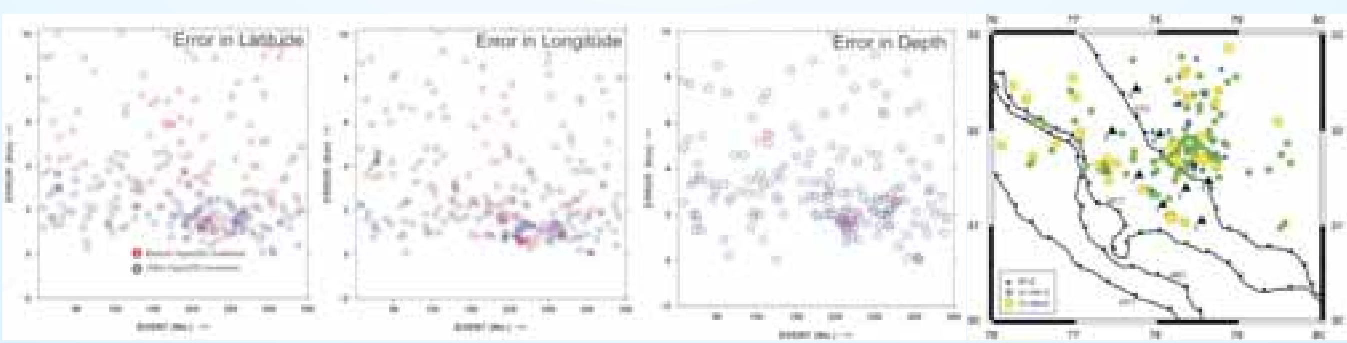

Fig. 18. Figure shows 166 earthquakes recorded in the Kinnaur region have been utilized for hypoDD relocation. Errors in latitude, Longitude and focal depth locations are also shown.

having epicentral locations near Kedarnath in Uttrakhand state, India have been identified. The similarities in waveform and focal mechanisms show that these earthquakes occurred on a single fault plane possibly located where the flexure of Indian continental plate begins. The source parameters of the events are estimated and reveal that a 4.9 ML event occurred during September, 2009 have high stress drop in this region. An attempt has been made to term these earthquakes as slow-creeping earthquakes at a single fault.

Attenuation Study in Eastern Ladakh

During 2014-15, a total of 10 local earthquakes have been recorded by at least 5 broadband seismograph stations of Ladakh Network consisting of 10 stations. These events have been analyzed for estimation of coda wave attenuation quality factor. The magnitude range of these earthquakes is 2.5-3.5 M_L, and depth 5-20 km. The frequency dependent average Qc relationships obtained at three different window lengths are $Qc = 9.74\ f^{1.08}$ (20 sec), $Qc = 13.98\ f^{1.02}$ (30 sec), $Qc = 17.52\ f^{1.04}$ (40 sec) respectively, with an average value of n (degree of frequency dependence) coming out to be 1.04, showing that frequency dependence is comparatively lower as compared to other seismically active regions. The increase of the quality factor Qc with increase in lapse time is observed in this study.

Receiver function Analysis for Satluj region, Himachal Pradesh

The teleseismic data recorded in Satluj region at 10 broadband seismic stations (Fig. 19) has been processed to estimate the Moho depth, Poisson's ratio through receiver function analysis. Here, Moho depth and Poisson's ratio for MUDH station is shown (Fig. 19). This analysis includes (i) construction of receiver functions through 3-D rotations of three component recordings, (ii) estimation of Moho depth and Poisson's ratio of the crust using a grid search approach after Zhu and Kanamori (2000). The analysis has been carried out for earthquakes with magnitude Mb5 having S/N ratio more than 2.5.

The receiver functions for above stations move out corrected for the converted phases and averaged over narrow slowness bins shown in the figure clearly depict sharp Moho conversions at different delay times followed by distinct P and multiples. We have determined Moho depth (Z_M) and average crustal Poisson's ratio (σ) (Fig. 20), following the approach of

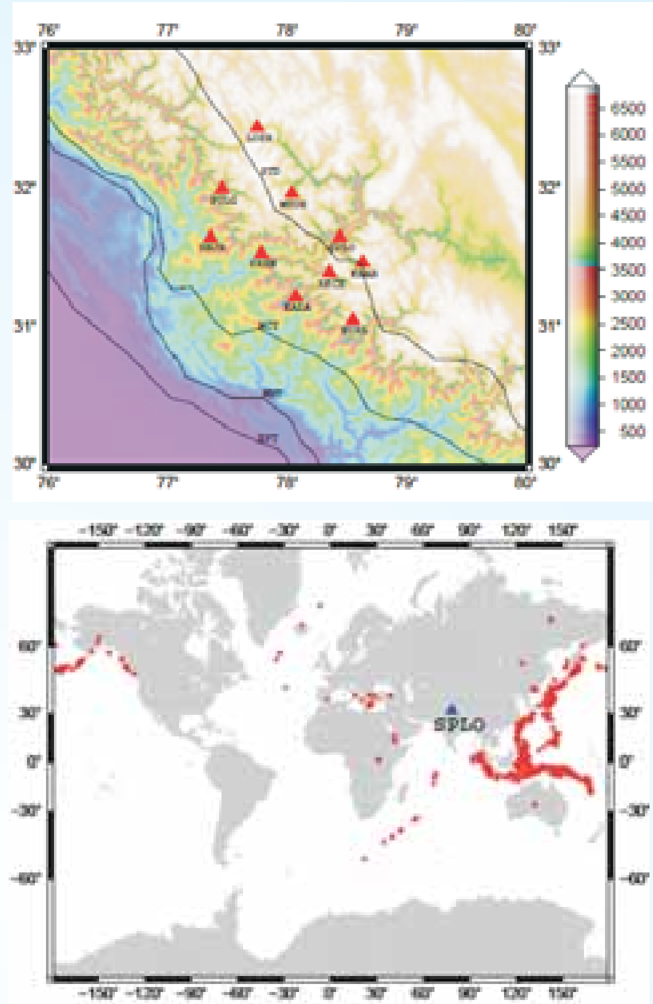

Fig 19. In this figure study area with 10 seismic stations (red triangles) are shown with the major tectonic units. In the side figure teleseismic events used for the study are shown with red stars and location of SPLO stations with blue triangle.

Zhu and Kanamori (2000). The scheme performs a grid search over the σ-Z_M space, to determine that σ-Z_M pair; which best explains the observed Moho conversions and its P and S multiples. The clear Moho multiples have resulted in well constrained estimates of 0.25±0.01 for σ and 28±1 km for Z_M, beneath the seismic station. While the determination of the Poisson's ratio is fairly reliable, the Moho depth estimate depends on the assumed average P-velocity of the crust (V_P). A simple 28 km thick crust with a lower than expected Poisson's ratio (0.25) is delineated beneath MUDH Station. Such a low Poisson's value is shared with the adjacent STD fault of India.

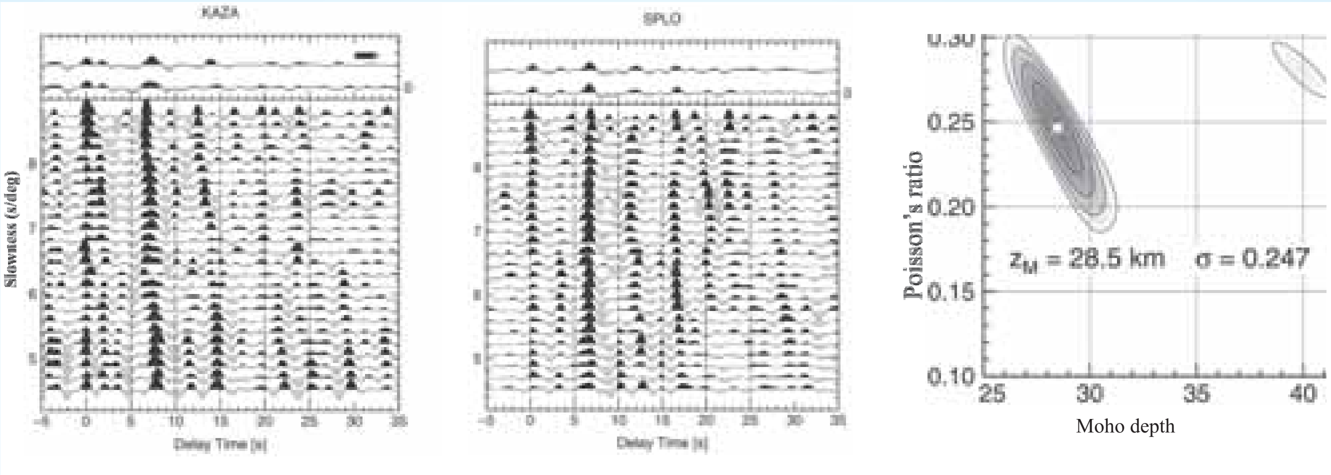

Fig 20. Figure shows stacked P-wave receiver function as a function of slowness and delay times at KAZA & SPLO seismic stations. Figure shows estimated value of Moho depth (ZM) and Poisson's Ratio (σ) at MUDH station.

TAT - 3.2:
Earthquake precursory studies in the Himalaya through Multiple Geophysical Approach

(*Naresh Kumar, Gautam Rawat and P.K.R. Gautam*)

Variation in the MPGO borehole data

The 68 m borehole executed at Multi-Parameter Geophysical Observatory (MPGO), Ghuttu, Garhwal Himalaya has continuous recording of radon in soil, air and underground water, and sub-surface temperature recording at different depth in the soil and underground water. In addition, the rainfall and atmospheric pressure is also measured continuously outside the borehole. Time series for all the parameters has a seasonal variation, but the amount of variation is high in the soil radon data and atmospheric pressure. Radon is considered a good precursor for earthquakes even though most of the published work is on hind sight. At MPGO Ghuttu continuous measurement is being taken at 15 intervals and the station is situated in the centre of High Himalayan Seismic Belt. More efforts are being made for searching the anomalous behaviour relative to the occurrence of moderate magnitude earthquake (M>=4.0) having epicentre distance <200 km. However, for the big size earthquakes event, the extent of the epicentre distance is more. Every year, the events of M>=4.0 are being analysed carefully. Besides, the past data of MPGO has also been searched for the comparative study. Detailed analysis has also been performed at the time of occurrence of 20 events recorded within a period of last four years. Few anomalous changes have been noticed in different time series and one related to borehole is depicted in figure

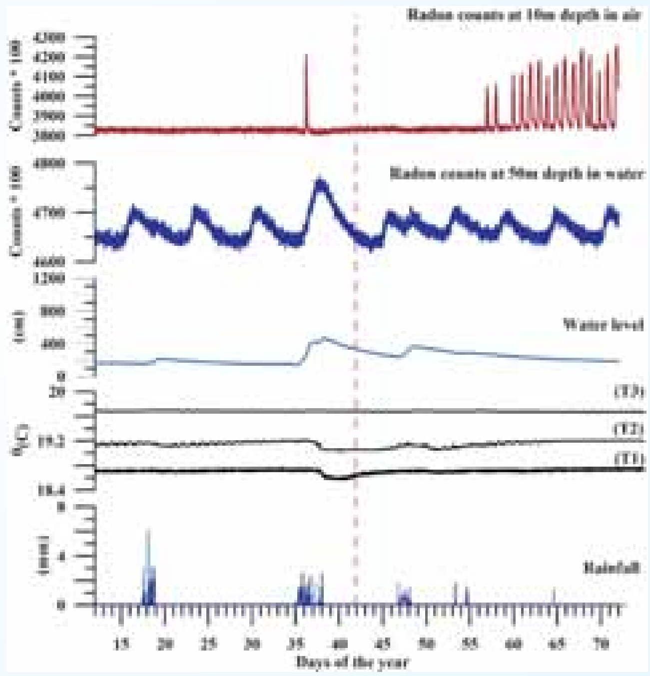

Fig. 21: Records of continuous time series of borehole data at MPGO Ghuttu recorded during Feb-Mar., 2013. The origin time of M4.3 recorded on 11-02-2013 from epicentre distance is marked with dotted red line.

21, where four day periodicity in the radon data of underground water has been observed during Febraury-March, 2013. Also there is daily periodicity for 10 days in the end of data set of soil radon recorded at 10 m depth in the borehole. These both variations are not related with the seismic activity and are not considered for analysis. During this period an earthquake of M4.3 occurred at ~62 km distance from the location of

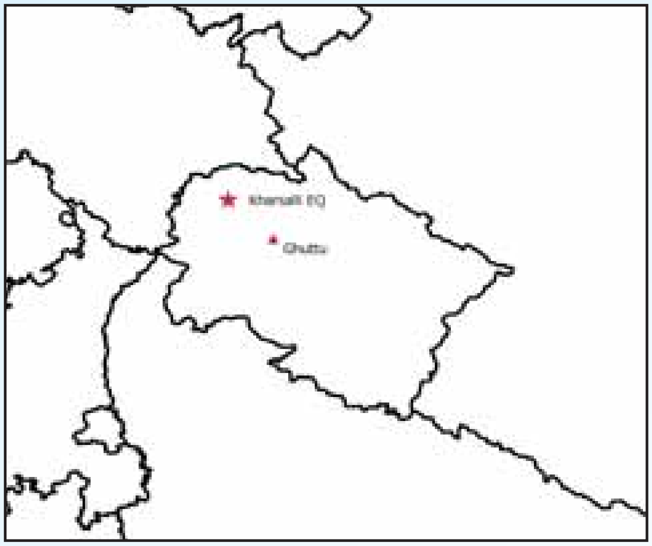

Fig. 22: Location of 22.07.2007 Kharsali Earthquake (star) with respect to MPGO Ghuttu (solid triangle).

MPGO, Ghuttu. The origin time of the earthquake is marked with red dotted line on the plot and careful scrutiny of the data indicate that anomalous changes in both the radon data sets which are noticed about 6 days before the earthquake. This anomalous change can be treated as precursory signal although at this time there is heavy rainfall and the enhancement of radon activity may also be influenced by hydrological changes.

Seismo-electromagnetic signals

In order to constrain the direction of seismo-electromagnetic signals, single station earthquake location algorithm based on singular value decomposition technique has been applied to Ultra Low Frequency (ULF) geomagnetic variation data for the month of July 2007. The entire time series is divided into segments of fifteen minute data sets and the single station location algorithm has been applied to each data sets. The algorithm decomposes the time series into three components. The component corresponding to largest Eigen value is the main geomagnetic signal, whereas components corresponding to lesser Eigen values are secondary contributions to main field. Figure 22 shows the relative location of Kharsali earthquake with respect to MPGO Ghuttu.

As it can be visualized from figure 23, the azimuthal variation for signal corresponding to the largest Eigen value is uniformly distributed to all direction, whereas azimuthal variation for signal component corresponding to lower Eigen value is having higher time segments for which azimuth is in between N15°W to N30°W. This indicate that there is some contribution of EM signals coming from N15°W to N30°W direction and this is the direction of Kharsali earthquake with respect to MPGO Ghuttu. These contributions are of SEM signals and if we observe simultaneous

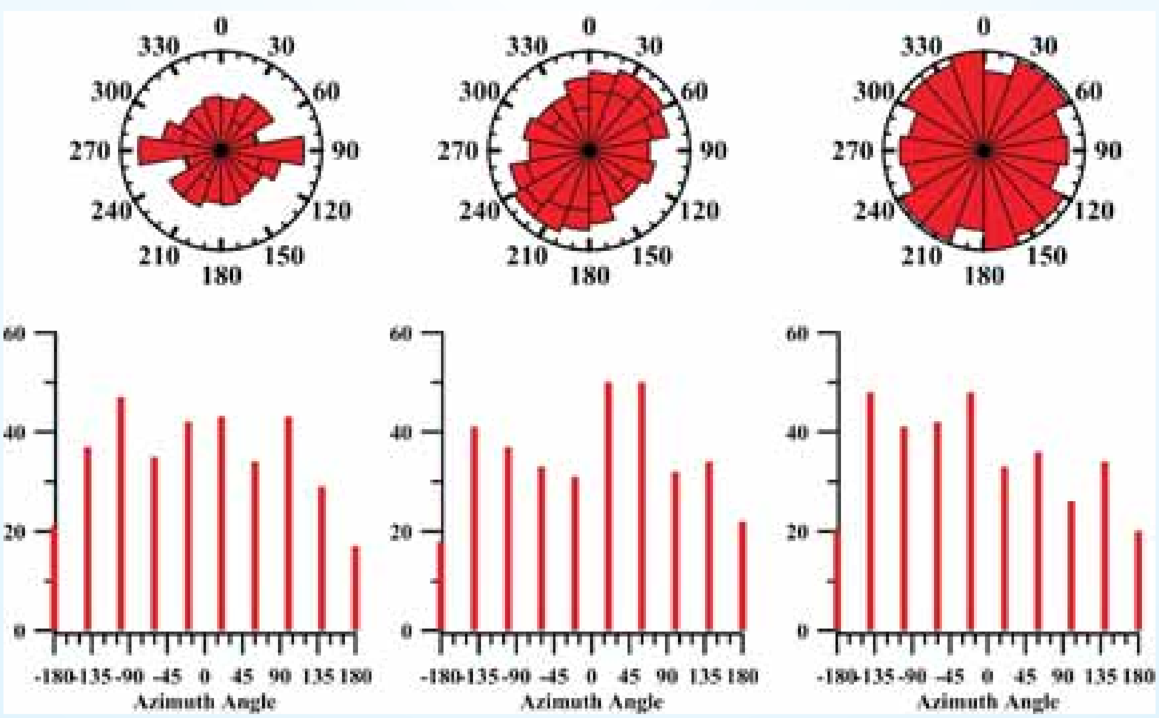

Fig. 23: Azimuthal distribution of signals corresponding to three Eigen values. Upper panel is the rose diagram of azimuthal variations, whereas lower panel is histogram of Azimiuth angels of different time series segments.

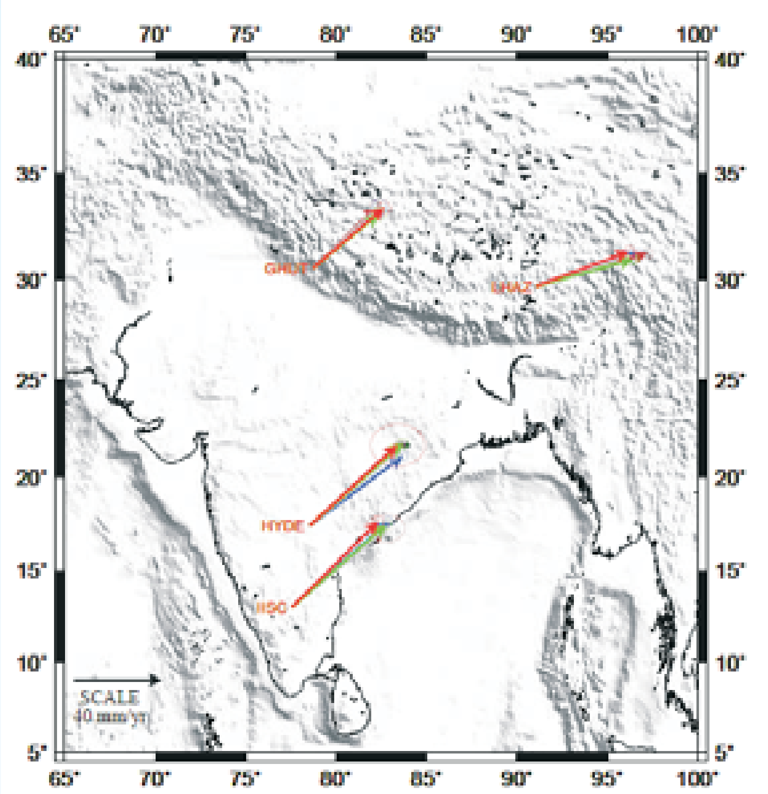

Fig. 24: Velocity vector of MPGO Ghuttu along with other station.

observation from more than one place, the direction can be fixed to a particular zone. Therefore ULF signals can be used for constraining the source zone of anomalous SEM signals in the background of global geomagnetic signals.

GPS Studies

In order to understand the crustal deformation and earthquake precursory study, we are monitoring a GPS network of permanent stations in the different parts of the Himalayan belt. Around ten GPS stations in the NW Himalaya, two in Ladakh region of J&K, and one in Delhi region are continuously being monitored. Eight years data from 2006 to 2013 of this network, along with data from ten IGS stations, which are available around the Indian plate have been analysed. The velocity vector of Ghuttu station along with other stations indicating the movement of Indian plate is shown in figure 24. The whole data has been analysed through the latest version of GAMIT (v. 10.40) and GLOBK software. GPS time series on year basis has been produced and the velocity vectors in ITRF08 reference frame have been obtained. Both horizontal as well as vertical variation for reducing the error has been analysed. For the precise interpretation of the results, the velocity has also been obtained in the Eurasian and Indian plate. Besides, in order to see the effect of Terrestrial Ground Water (TWS) on the Himalayan seismicity, the GPS and TWS data have been combined simultaneously.

TAT - 3.3

Shallow sub surface studies and site response estimates in 1905 Kangra seismic zone and urban sites of Frontal Himalaya

(A.K. Mahajan (on lien) and A.K. Mundepi)

Soil characteristics in Doon valley (northwest Himalaya, India) by inversion of H/V spectral ratios from ambient noise measurements

Doon valley lies between the Main Boundary Thrust (MBT) and the Main Frontal Thrust (MFT) and falls in zone IV of the seismic hazard zonation map of India, experiencing several major earthquakes (M>6) in the historical times. The fast urbanization process in the valley is a concern for the future possibility of earthquakes damaging the area, and about the dangerous consequences of local amplification.

Microzonation studies based on ambient noise measurements can be used to estimate the local soil characteristics in urban areas, through cheap and non-invasive techniques. The microtremor H/V studies were carried out in Doon valley for detail mapping of the resonant frequencies at 214 sites along the valley. Besides, the combination of the borehole data and the H/V curves has allowed the H/V inversion and then, the estimation of the Vs profiles, at eight sites distributed along the valley (Fig. 25). The different H/V analysis and the inversion of the H/V curves through the neighbourhood algorithm are used to characterize the sedimentary basin underlying the Doon valley,and the identification of the areas that may be more susceptible to amplify soil shaking during a strong earthquake. It has been observed that the fundamental resonant frequencies range from approximately 0.2 to 8 Hz (Fig. 26). The frequencies below 1 Hz are generally related to the extent of the Quaternary deposits in the Doon valley, while the frequencies higher than 1 Hz are related to sediments overlaying Siwalik outcrops.

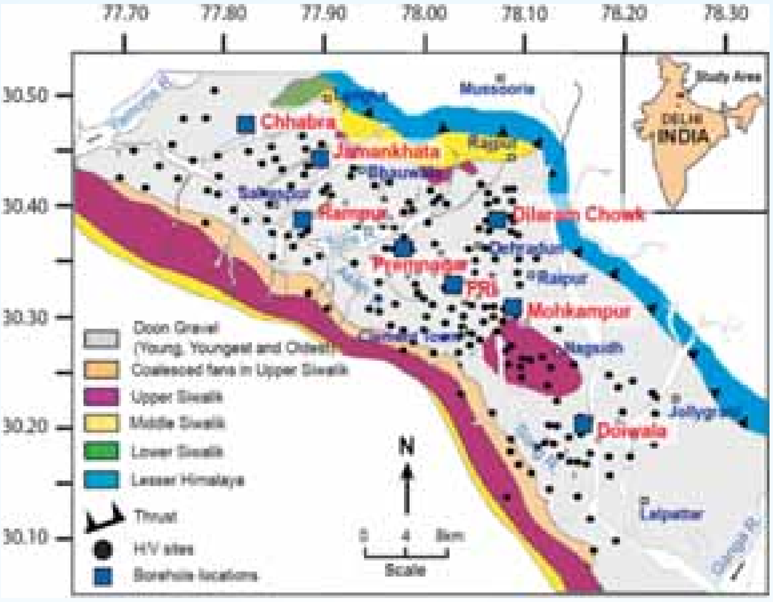

Fig. 25: Geological map of Doon Valley. The locations of the H/V measurements and the borehole drills are shown by black dots and a purple square, respectively.

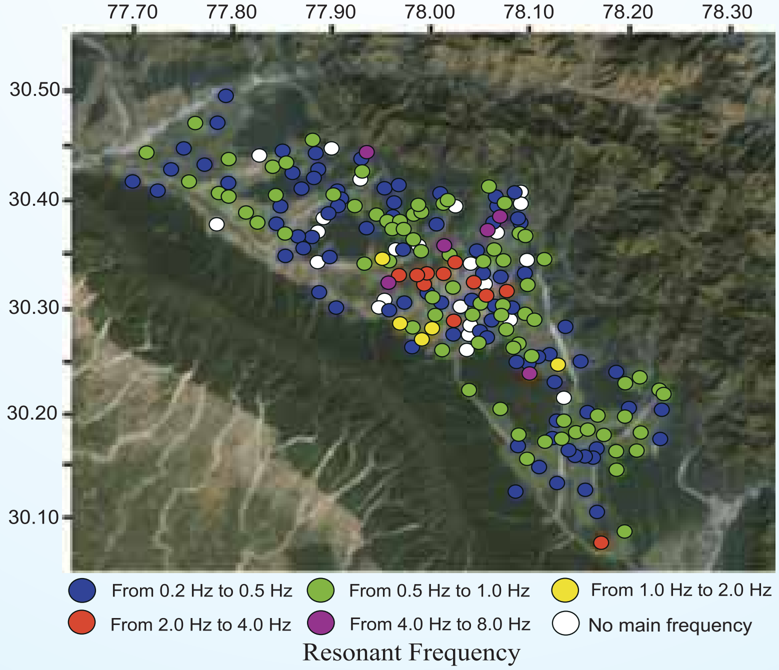

Fig. 26. Map of fundamental resonant frequencies along the Doon Valley. Resonant frequencies appear grouped in different ranges are marked with colours.

Also, estimation of the shear wave velocity (Vs) profile and the calculation of the average shear wave velocity of the unconsolidated sediments is done (Fig. 27). It is found that, the deepest interfaces are located in Doiwala and Mohkampur (southeast area of the valley), below this stratum at a depth of 265-530 m, we identify the bedrock, classified as rocks by the NEHRP site class. According to the NEHRP classification, units of very dense soils and soft rocks are found at the depth of 80-144 m. The deepest interfaces are also estimated in Jamankhata, Rampur and Premnagar, which are located near the central area of the valley. The Vs parameter ranges approximately from 163 m/s in Jamankhata to 256 m/s in Dilaram Chowk. Taking into account the obtained Vs values, the valley can be classified as class D (stiff soils), according to NEHRP classification, with the exception of Jamankhata site (class E). A shallow low-velocity layer is observed in the central region of

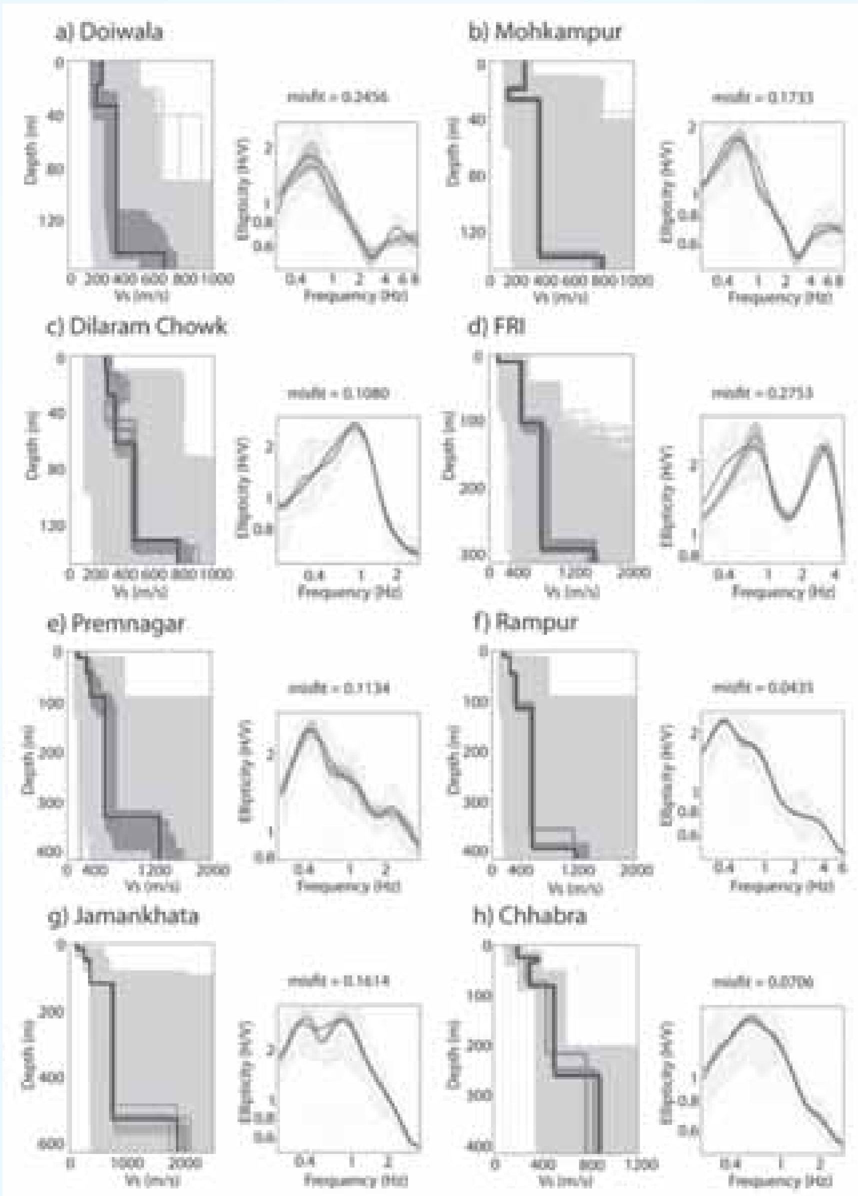

Fig. 27: S-wave velocity profiles obtained at the eight studied sites. On the left, the best-fitting model (in black), the models comprised inside the range defined from the minimum misfit plus 10% range (in dark gray), and all the tested models (in light gray) are shown. On the right, the H/V curve associated with the best model (dark gray) and the ones associated with the models lying inside the minimum misfit +10% (light gray) are shown together with the experimental H/V curve (black). The minimum misfit value is shown on top of the H/V plot.

the Doon valley (FRI, Premnagar, Rampur and Jamankhata) with a velocity between 120 and 165 m/s. Thus, depending on the thickness of this low-velocity layer along the valley, we might find areas of soft sediments (class E), being likely to higher seismic hazard.

Summarizing, the accomplished work has contributed to the characterization of the sedimentary basin and the identification of the areas that may be more susceptible to amplify soil shaking during a strong earthquake.

TAT - 3.4
Identification of Active Faults, Paleo earthquake ruptures and quantification of fault slip history between HFT and MCT: Implications to Seismic Hazard Assessment in Indian Himalaya

TAT - 3.4a
Active tectonics and paleoseismological studies within the zones of Himalayan Frontal Thrust and Main Central Thrust in Uttarakhand and Himachal Himalaya

(G. Philip and N. Suresh)

The distribution and relative placing of various lithological units and pattern of deformation in the trench excavated across the Logar Fault, in the Kumaun Himalaya suggest normal faulting. This fault in part also follows the older mega thrust zone of weakness such as the MBT. The faulting has created a linear depression in front of the north facing scrap, which subsequently filled-up by sediments brought by the southerly flowing tributaries of Logar Gad. Although there are few poorly sorted units with matrix supported coarse gravel, the stratifications in the finer sedimentary units also corroborate development of sag pond in front of the scarp and the subsequent deposition largely under lacustrine environment.

The lithologic units as exposed in the trench (Fig. 28) show their vertical displacement. The orientation of the clasts and the finer stratification within the sedimentary units suggest the fluvial depositional environment. The non-uniformity in thickness of individual litho-units supplements varying discharge conditions and paleo-hydrological environment prevalent in the area. Composed of loose and unconsolidated material, the significant height of the fault scarp (15-38 m) suggest that it must have developed due to multiple faulting events occurred along the same fault plane/system with a cumulative displacement up to 38 m. This is also corroborated with the absence of equivalent/comparable lithological units in the footwall as compared with the hanging wall. Hence, by considering the disposition of the sedimentary units and its distribution, our preliminary analysis suggests the following chronological sequence of the recent geological events in the Logar area.

i. The sediments derived from the Lesser Himalayan rocks widely deposited as Unit A in the form of a coalesced Logar mega alluvial fan. The faulting of the fan created a geomorphic south side up linear scarp with a depression in front, which subsequently led to local ponding.

ii. The linear fault scarp remained exposed to sub-aerial weathering and erosion resulting to deposition of Unit B and soil formation at the top surface of the unit. Based on the OSL age it is inferred that the timing of the fault activity to be before 20 ka and which consequently initiated the deposition of these units.

iii. A second phase of faulting (Fault-II) along the same fault plane of the Logar mega fan has further uplifted the footwall. The fault has vertically displaced the two units. The faulting also led to deposition of subsequent units in the fault depression. It is presumed that immediately after the faulting, deposition of the clast to matrix supported Unit C initiated.

iv. During faulting, the units have also been dragged along the fault plane and the footwall has attained the present day height of 15 m from the ground level. The depression developed due to faulting has facilitated the deposition of subsequent units E, F and G.

The mappable length (7.5 km) of the Logar Fault indicate that it is not long enough to produce a great earthquake (Mw>8). However, it is capable of generating secondary faulting and further deformation in the hanging wall. The geomorphic south side up expression of the Logar Fault, which also coincides to the Himalayan mega thrust, the MBT, suggest subsequent tectonic activity along the MBT. The sequence of faulting of Logar mega fan suggests its convincing genetic link with seismic activity in this region, and we do not rule out such possibility of faulting. The Logar active fault system identified to the north of the HFT indicates that elastic strain release within the hanging wall is not limited to the front, but it is dispersed above the decollement over a broad area.

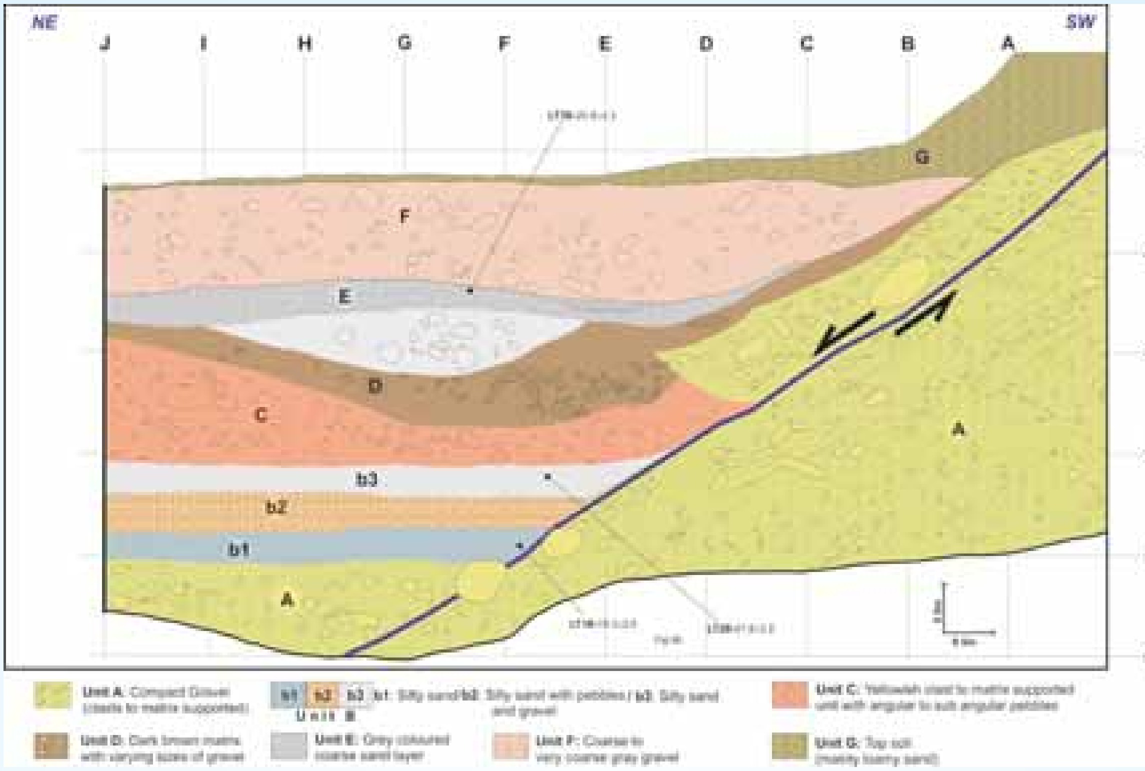

Fig. 28: Trench excavation at Bairasari showing part of the vertical section of the trench showing different litho-units (A-G) which are individually identified based on the type of clast and matrix and their distribution. The trench wall is gridded by 1m x 1m grid. The arrows show relative displacement of the units of the normal fault. Unit A is observed both in the Foot wall and the Hanging wall. The clasts in the FW are also aligned parallel to the fault plane. Except for variation in thickness, the units (B-G) do not show any deformation in the trench indicating their deposition under fluvio-lacustrine environment after the faulting. The OSL sample locations are shown with their ages.

The Logar Fault system may be one of the several secondary hanging wall structures initiated to accommodate rupture during large magnitude Himalayan earthquakes. The earthquakes to occur within a future time span of concern to society will be therefore very important in the highly populous region of the sub-Himalayan terrain of the northwestern Himalaya. The study is in progress to establish the slip rate and to estimate the seismic hazard in this segment.

Ground Penetrating Radar (GPR) and Electrical Resistivity (ERT) surveys have also been carried during the report year across three different active fault systems in the northwestern frontal and sub-Himalaya. The HFT and its supplementary reactivated faults reported earlier by our trench excavation survey at Kala Amb have also been verified through the above surveys. Identification of prominent liquefaction features in the HFT zone, observed at Kala Amb is one of the significant findings of the above survey. Similar surveys have been carried out in Doon valley at Bhauwala and the fault system (Bharli Fault) in the Trans-Yamuna segment of the NW Doon valley. Delineation of subsurface tectonic features using geophysical methods should help us in integrating geological and geophysical means to establish the active fault systems in the study area.

TAT - 3.4b

Timing, size, and lateral extent of earthquake ruptures along the Himalayan Frontal Thrust *(TSLER-HFT)*

(R. Jayangondaperumal and Pradeep Srivastava)

Late Quaternary shortening rates on the Jawalamukhi Thrust (JT), the Soan Thrust (ST) and the Himalayan Frontal Thrust (HFT) are estimated. The shortening rates on the JT are 3.5-4.2 mm/year over a period 32-30 ka. The ST yields a shortening rate of 3.0 mm/year for 29 ka. The corresponding shortening and slip rates estimated on the HFT are 6.0 and 6.9 mm/year during a period 42 ka (Fig. 29). On the back thrust of Janauri Anticline, the shortening and slip rates are 2.0 and 2.2 mm/year, respectively, for the same period. The results constrained the shortening to be distributed largely across a 50 km wide zone between the JT and the HFT. The present study indicates that the high magnitude earthquakes can occur between the locking line and the active thrusts.

Quaternary tectonic activity across the Jammu and Kashmir fold-thrust belt is poorly known because of the long period of inaccessibility of the region, and because the latest and only large earthquake recorded in the region occurred in 1555 A.D (Fig. 30). Our studies show the deformation is localized during the Late-Quaternary, and we determined shortening rates across the structures, such as, Main Boundary Thrust (MBT), Medlicott Wadia Thrust (MWT), Himalayan Frontal Thrust (HFT) and Surin Mastgarh anticline (SMA) by analyzing the geometry and chronology of geomorphic markers. The MBT in this region ceased moving at least ~30 ka ago. On the contrary, the more external MWT and MFT, both merging at depth on the sub-flat detachment of the Main Himalayan Thrust, exhibit hectometric-scale deformations accumulated during the last thousands of years. The total shortening rate absorbed by these faults over the last 14-24 ka is between 13.2 and 27.2 mm/yr (Fig. 30b; 11.2 ±3.8 and 9.0 ±3.2 mm/yr, respectively). Part of this deformation may be associated to the geometry of the Chenab reentrant, which could generate an extra oblique component. However, the lower bound of our shortening rates is consistent with previously determined geodetic rates. Active deformation on these structures follows an in-sequence/out-of-sequence pattern, with breaking of both ramps being possible for earthquakes triggered on the main detachment.

TAT - 3.4c: Morphotectonic evolution of the Himalayan frontal belt between Kosi and Kali rivers, Kumaun Himalaya

(Khayingshing Luirei)

Stream-gradient Index (SL) and Steepness Index (Ks) have been computed for streams/rivers cutting across the Himalayan Frontal Thrust (HFT) in Ramnagar-Kaladhungi section of the mountain front. These indices have been computed to analyze the tectonic activity of the Main Boundary Thrust (MBT), Himalayan Frontal Thrust (HFT) and other intra-formational thrusts. The SL and K_s indices were calculated to decipher the relationships amongst stream power, channel morphology and bedrock resistance to erosion and tectonic activity. In order to ascertain the fluvial response to terrain stability/instability, these indices provides a first order information towards the role of endogenic and exogenic processes. In the area vicinity of thrusts, such as MBT, Dhikala Thrust (DT), Tagariya Thrust (TT), Pawalgarh Thrust (PT) and the HFT show higher Ks values which reflects differential uplift, and can be ascertainied by anomalous changes in Ks.

The observed anomalus values of Ks along major thrust indicate enhance uplift along the structural boundaries. The higher and lower Ks vaules away from major thrust could be due to changes in lithologies that could have played major role for developing knick points. The computed values of Ks along Dabka and Baur rivers show knick points at three places in the hanging wall of the Dhikala Thrust. These knick points suggest episodic uplifts. Along the stream profile of the Garuni Gada

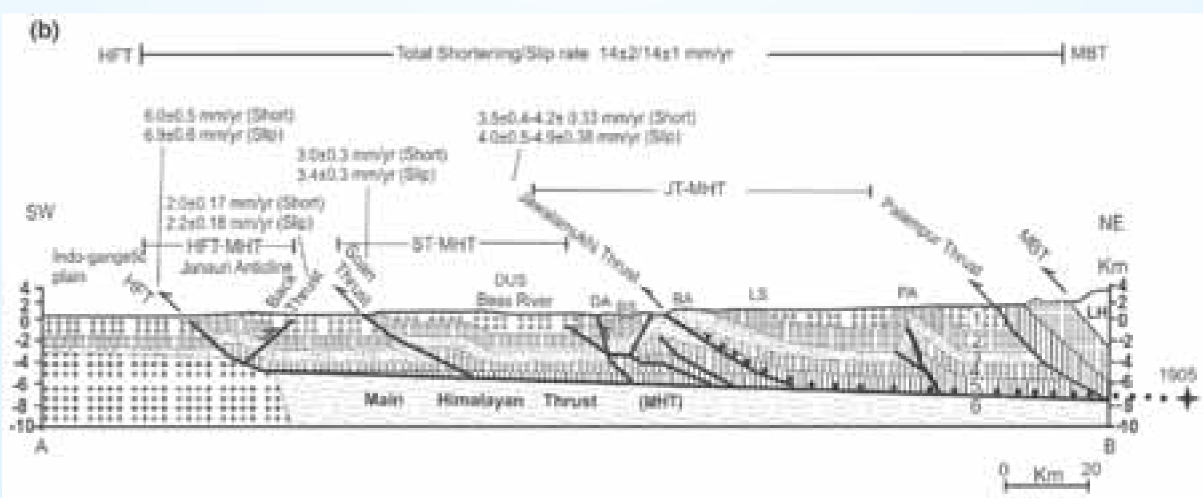

Fig. 29: Cross section showing distribution of shortening rate across the Kangra recess.

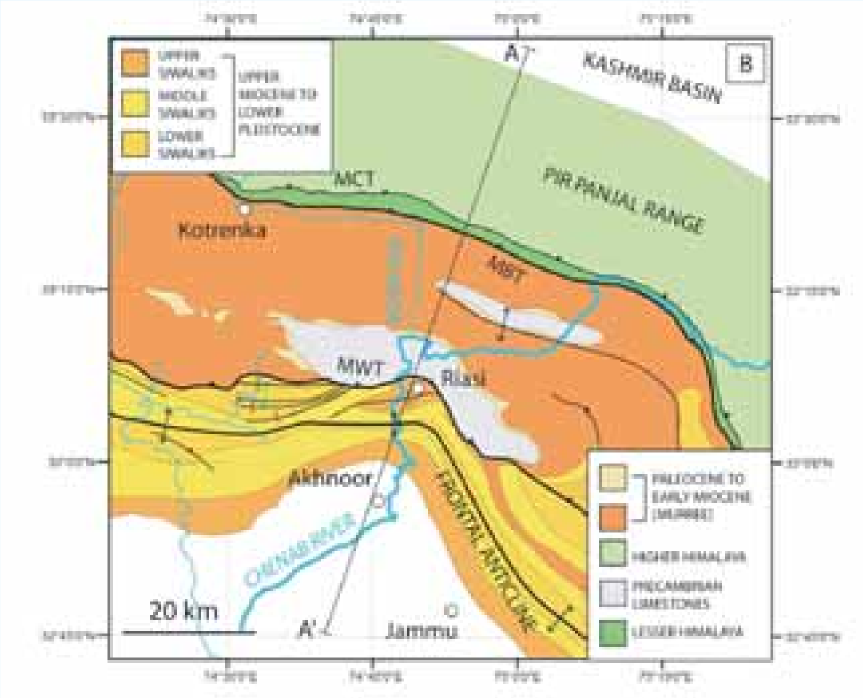

Fig. 30a: A simplified map of western part of NW Himalaya, A-A' location of the cross section is also shown.

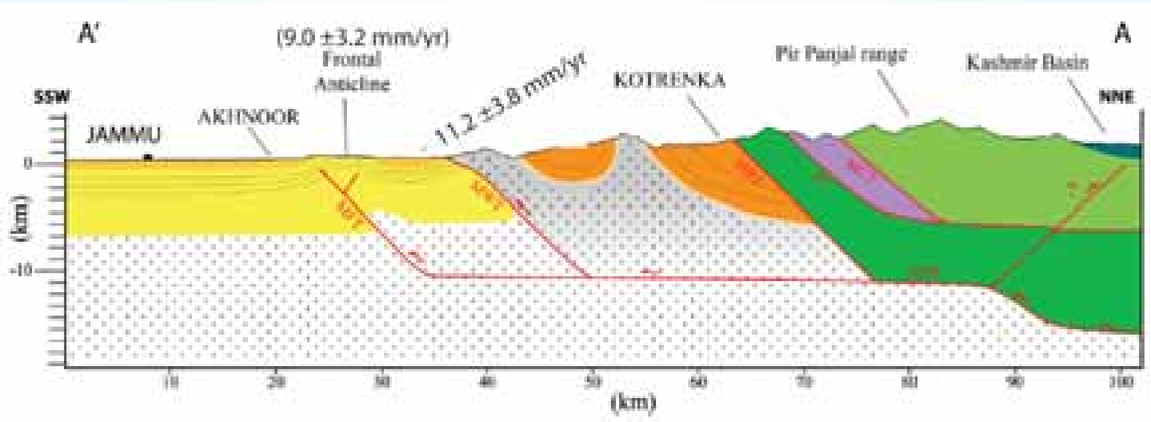

Fig. 30b: A crustal cross section across the fold thrust belts of NW Himalaya shown as A-A' in figure.

prominent knick point is demarcated across the HFT. Further upward along the stream channel, two knick points were observed, which may be formed due to the Pawalgarh thrusting, where deformation has not reached the surface, for example, as observed to the west of Pawalgarh. The Ladwa Gad flowing close to the Garuni Gad also has a similar profile, with prominent knick points at the HFT. Knick points are also observed along the longitudinal stream profile of the Kusum Raula in the HFT zone and Pawalgarh Thrust. Longitudinal profiles and SL of the Dabka River suggest changes in profiles and gradients, as the river flows across the thrusts during its course in the bedrock channel, while in the alluvial channel there is no significant change. Across the HFT the Dabka River has a smooth profile, while north of the Pawalgarh Thrust, change in longitudinal profile is observed. This portion of the river is characterized by deep cut valleys resulting from uplift along the Pawalgarh Thrust, and erosion of the Upper Siwalik rocks.

Profiles across the Tigariya and Dhikala thrusts show prominent knick points in the hanging wall as confirmed by sudden changes in steepness index. The longitudinal profile of the Baur River indicates a steady increase in stream gradient, with knick points. The longitudinal profile of the Kacharpani Sot does not show prominent change in gradient near the HFT, but sudden change in stream gradient is noted in the hanging of the Pawalgarh Thrust. The Dhuni Gad exits form mountain front into the Gangetic plain in the form of a waterfall (~7 m), which is also reflected in the longitudinal profile, where sudden change in stream gradient is observed. The Kali Gad, a very small stream originating in the upwarped mountain front, also shows sudden change in longitudinal profile. The longitudinal profile of the Nauli Gad shows no change in stream gradient; just near the mountain front it flows parallel to the HFT. The reason for sudden change in the longitudinal profiles of the Kusum Raula, Ladwa Gad, Garuni Gad and Dhuni Gad in the hanging wall of the HFT is attributed to calcium carbonate layers in the sediment profiles and uplift along the HFT. Such layers are lacking in the Kacharpani Sot, Nauli Gad and Dabka River sediments.

The SL has been divided into three groups. Group A is represented rivers cutting across the HFT, intra-formational thrusts and the MBT, Group B by streams cutting across the HFT and intra-formational thrusts, and Group C by those cutting across the HFT only. The Dabka and Baur rivers come under Group A. The SL index calculated along these rivers show anomalous values in the vicinity of the MBT and HFT. SL values for the Dabka River ranges from 460 to 870 in the MBT zone and 70 to 400 in the HFT zone. SL values for the Baur River in the MBT and HFT zones range from 61 to 176 and 237 to 575, respectively. SL values of the Nauli Gad and Kacharpani Sot are grouped under Group B. In the Pawalgarh Thrust and the HFT zones, SL values of the Nauli Gad show a pronounced peak with SL values of 152 and 138, respectively, while SL values of the Kacharpani Sot in these thrusts zone are 190 and 110, respectively, with a maximum SL peak in the HFT zone.

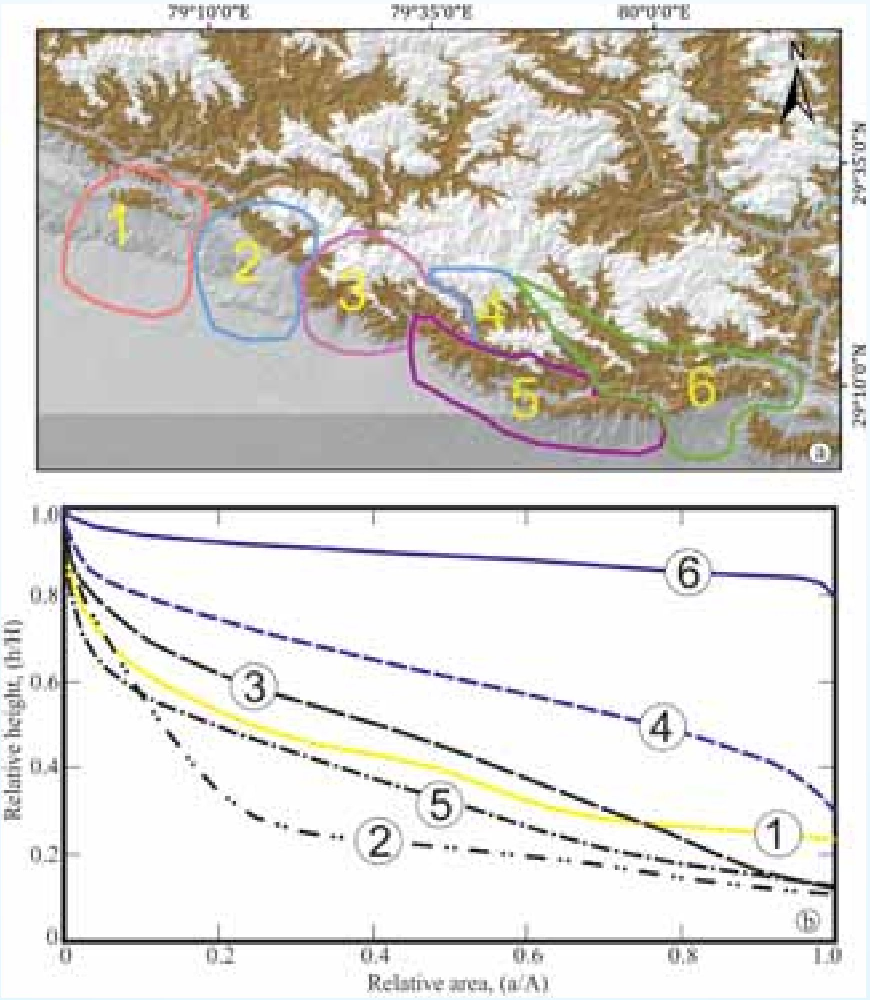

Fig. 31: Location of six drainage basins (sub area) in the frontal part of Kumaun Himalaya; showing different Hypsometric Curve and different values of Hypsometric Integral.

SL values of the Kusum Raula, Ladwa Gad, Garuni Gad and Dhuni Gad are grouped under Group C. The sudden break in cross longitudinal profiles of these streams in the HFT zone are represented by SL peaks with maximum and minimum SL values observed in the Kusum Raula (900) and Dhuni Gad (295).

The percentage Hypsometric curve which relates to horizontal cross-sectional area of a drainage basin to relative elevation above basin mouth has also been computed for the frontal part of the Kumaun Himalaya. Stages of youth, maturity and old age in regions of homogenous give a distinct series of hypsometric form. The area under study was divided into six sections for hypsometric analysis, sub-area 4 (0.613) and 6 (0.886) gives high Hypsometric Integral (HI) values relative to very low and intermediate values in sub-areas 1 (0.408), 2 (0.278), 3 (0.444) and 5 (0.340), which indicate that the section under sub area 4 and 6 i.e., the eastern section is tectonically more active than the central and the western most sections (Fig. 31).

TAT - 3.5

Geoengineering studies and the petrophysical characteristics of rocks in the selected transects of Uttarakhand and Himachal Himalaya

(Vikram Gupta)

The quantification of various geo-engineering properties, mainly the strength characteristics of soil and rocks of the Mussoorie and Nainital townships were carried outduring the reporting year. The northern facing failed slope near the Surabhi Resort landslide, located about seven km away on the Mussorrie-Kempty road has been modelled using Finite element analysis. Modelling has been carried out by Phase^2 software using shear strength reduction approach. Two models viz. debris and rock mass were taken into consideration for the present study. It has been observed that the factor of safety for the failed slope is 0.28 and 0.83 for the debris and rock model, respectively. It has also been noted that after the occurrence of landslide, the shear strain and displacement is maximum in the crown portion of the landslide. It is of the order of 0.17 and 1.7 m for the debris model and 0.001 and 0.07 m for the rock model. This has also been evidenced in the form of cracks in the building of Surabhi Resort and presence of subsidence zones in the Mussoorie International School. The slopes around the Surabhi Resort landslide have also been monitored with Total Station, and it has been observed that there is continuous movement on the slope. This demands an immediate intervention on the slope for its corrective measures.

Besides, in order to ascertain the soil-rock interface, Ground Penetrating Radar (GPR) survey has been carried out at about 12 different locations in the Nainital township. The GPR profile ascertains that the thickness of overburden on the slopes in the Nainital township is of the order of 5-10 m.

Geo-engineering study has also been carried out in the Yamuna and the Bhagirathi valleys. Field work has been carried out for the collection of block rock samples. An inventory of landslides between Uttarkashi and Bhatwari in the Bhagirathi valley and between Barkot and Yamunotri in the Yamuna valley has been prepared. The spatial distribution of these landslides was correlated with various geological and geomorphological factors in the area. It has been observed that there is not any preferential occurrence of landslides in particular rock types.

TAT - 4: BIODIVERSITY - ENVIRONMENT LINKAGE

TAT - 4.1

Geobiological study of the Neoproterozoic-early Cambrian sequence of carbonate belt, Lesser Himalaya including study of microbiota and microbiotic processes and their interpretation in terms of palaeo-environment and correlation of evolutionary trend with global bioevents

(Meera Tiwari and Santosh K. Rai)

In the last few decades acritarchs have emerged as the most significant proxies for recognition of biozones and subdivision of the Neoproterozoic successions. The Ediacaran successions, in particular, are characterized by the occurrence of prominent acritarchs, which are large in size and exhibit unique morphological characteristics. These Ediacaran acanthomorphic acritarchs thus provide a new potential tool in the stratigraphy of the lower-middle Ediacaran successions.

The Ediacaran large Acanthomorphic acritarchs have been reported worldwide from several basins, namely south China, south Australia, east European Platform, Siberia, northern India and Svalbard. As more information on acritarch occurrences worldwide become available, the potential for refinement of biostratigraphic zonation and global correlation of Ediacaran sequences increases. Large acanthomorphic acritarchs have been reported from the Infrakrol Formation of Pachmunda and Nainital synclines of Lesser Himalaya.

Chert samples of Krol 'A' Formation exposed in Khanog and Rajgarh synclines, record well developed and diversified assemblage of Ediacaran large acanthomorphic acritarchs. This assemblage contains *Appendisphaera fragilis*, *A. grandis*; *Asterocapsoides* sp. A, *Asterocapsoides* sp.'B'; *Cavaspina acuminata*, *C. basiconica*; *Eotylotopalla dactylos*; *Knollisphaeridium* sp.; *Papillomembrana* sp. and *Weissiella* cf. *grandistella,* which show a close resemblance with the upper Doushantuo or *Tanarium anozos*- *Tanariumconoideum* assemblage of China. The stratigraphic similarities also suggest a coeval deposition of the Krol 'A' and Doushantuo formations. With better documentation of the acritarch assemblage from Infrakrol and Krol, a definite biostratigraphic correlation between the Ediacaran successions of Krol Belt in India and Yangtze Gorges region in China may become feasible. The absence of Tanarium, the marker acritarch taxon of the Upper Doushantuo assemblage in the Krol Group, is very peculiar. Based on the study by Liu et al. it may be inferred that the Krol assemblage may be correlated to one of the four zones described earlier by Grey under the Ediacaran Complex Acanthomorph Palynoflora of south Australia.

TAT - 4.2

Bio-event stratigraphy of the Lower Paleozoic successions of Himalaya in context with global event stratigraphy

(S.K. Parcha)

The sedimentary history of the Tethyan Himalayan region as a whole and that of the Lower Paleozoic times in particular are under a considerable debate throughout. Evaluation of bio-events in the Lower Paleozoic successions of Zanskar-Spiti, Kumaun-Garhwal, Kashmir and their relation to these events in the Himalayan region will help to bring the precession in global Correlation and the relationship of organisms. The Lower Paleozoic deposits of Himalaya are critically significant for understanding the depositional environments as well as the chronology and evolution of contemporary tectonic episodes.

Trace Fossils and Microbialy Induced Sedimentary Structures (MISS) from Chandratal Area

Trace fossils and Microbially induced sedimentary structures (MISS) are first time documented from the early Cambrian succession of Chandratal section in Spiti Basin. The marine succession contains different assemblage of trace fossil representing mainly horizontal and branched structures mostly belong to arthropods, annelids and polychaets. These trace fossils are preserved in shale, siltstone and sandstone beds, whereas MISS were preserved below the trace fossil horizon in fine grained sandstone. The latter represents regular or irregular pattern and occur in patches on the bedding surface. They are also observed lying below the trace fossil horizons. The MISS is mostly formed in the shallow marine settings by interaction of microbial mats with the physical dynamics of sediments. These structures have a distinctive morphology which represents changes in the depositional environment. Therefore, they can be used as an element to define the ancient life, and also as an indicator of interaction between microbes and depositional environments. The traces present in the lower level belong mostly to vermiform animals, whereas, higher up in the succession behaviour activity of arthropods as well as annelid and polychaetes were observed.The distribution of trace fossil in the studied section reflects energy level from low to moderate.The presence of the MISS in basal part of Lower Cambrian succession ascribed to the absence of grazing organisms during that time. The presence of microbially mats in the fine grained sandstone reflects that the deposition has taken places in photic zone under shallow marine environment. The described trace fossils in the succession reflect the presence of suspension and deposit feeding animals in response to changing environmental deposition. Their complexity signifies depositional environment oscillating from subtidal to intertidal.

Sedimentary Geochemical studies of the Batal section

The geochemical studies have been carried out on the Neoproterozoic metasedimentary rock of the Batal Formation, Himalayan Group in the Spiti Basin to understand their provenance and depositional environment. The geochemistry of the sediments suggests that they were derived from recycled quartzose sediments. The studies also indicate that the sediments were deposited under low to moderate oxygenated environmental conditions. The recycled sources represent quartzose sediments of mature continental provenance, and the derivation of the sediments could be from highly weathered granite, gneiss terrain and/or from a pre-existing sedimentary terrain. Further, the sandstones reflect the highly weathered source area with presence of clay minerals that were derived during the cold period.

Cambro-Ordovician succession of the Himalaya

The Cambro-Ordovician succession is deposited as a fossiliferous succession with comparatively few breaks in sedimentation. One such break covers a long span ranging from Paibian to Tremadocian. In the Indian subcontinent so far no fauna equivalent to this age occurs, and the record of this time gap is represented by an angular unconformity in Spiti and Zanskar, but in Kashmir it is characterized merely by a faunal break. This angular unconformity between Paibian stage of Cambrian with overlying Tremadocian stage of Lower Ordovician has substantial local relief and is of regional level. The Lower Cambrian succession in the Tethyan Himalayan region is represented by a transgressive facies which accounts for its widespread deposition even in Lesser Himalaya. However, the regressive phase started in the Middle Cambrian, the effect of which seems that the deposition is constrained merely to deeper Tethyan region, but this regression continues and culminates in a non-deposition in Upper Cambrian.. The Cambro-Ordovician break characters a total change in the lithofacies and biofacies whereby shallow coastal sedimentation of Middle Cambrian and early Late Cambrian is followed by turbidite facies of Middle Ordovician with trilobites dominating in the Cambrian and brachiopods in the Ordovician which has been observed in Kashmir, Spiti-Zanskar basins.

Ordovician- Silurian successions in the Pin valley of the Spiti Basin

In the Spiti basin it has been noticed that the diversity of the fauna as well as microfacies increases. The reefal sequence is overlain by arenaceous rocks. The Pin Formation of the Spiti Basin comprises of thick sedimentary succession. Based on the presence of conodonts various authors have assigned Upper Ordovician age of the lower part where as the upper part is characterized by lower Silurian. On the basis of distinct lithologies the Pin section is subdivided into seventeen distinctive lithological units. The basal unit comprises of medium to fine grained siliciclastic which is followed by sandy to pure nodular limestone, which are succeeded by a few meters of silt and sandstones. This is overlain by sandy to pure limestone yielding abundant remains of calcareous algae, corals, trilobites, brachiopods, stromatoporoids, bryozoans, conodonts, echinoderms and molluscs. The lower upper part in particular comprises of a highly varied carbonate succession and contains a rich reef-related fauna and flora. The top of the sequence consists of strongly silicified sandstones and calcareous sandstones. In the late Ordovician Bryozoa appear in the lower part of the Pin Formation, becoming most abundant and diverse in the upper part of the section. The Ordovician-Silurian boundary seems to be represented by hiatus. The majority of bryozoan taxa are restricted to limestone and nodular limestone beds. The carbonate framework and microfacies in general indicates shallow marine settings.

Trace fossil in Guryul ravine, Kashmir

The Kashmir Basin has a complete Cambro-Triassic sequence and thus holds a unique position in the geology of Himalaya.The Guryul Ravine of the Kashmir Basin is represented by the Late Permian (Changhsingian) succession, and is mainly comprised of mixed siliciclastic-carbonate sediments deposited in a shallow-shelf or ramp setting. The present assemblage of Ichnofossils is the first significant report of trace fossils in the Guryul ravine since early reports in the 1970s. The Ichnofossils reported from this section include: Diplichnites, Dimorphichnus, Planolites, Monomorphichnus, Skolithos along with burrow, scratch marks and annelid worm traces? The ichnofossils are mainly preserved in medium grain sandstone-mudstone facies. The Ichnofossils are widely distributed throughout the section, and are mostly belonging to arthropods and annelid origin. They show behavioural activity that of mainly dwelling and feeding, and evidence of the dominant presence of deposit feeders. The vertical to slightly inclined biogenic structures are commonly recognized from semi-consolidated substrate which are characteristic features of the near shore/foreshore marine environment, with moderate to high energy conditions. The topmost layer of silty shale contains trace fossils like Skolithos and poorly preserved burrows. The burrow material filled is same as that of host rock. The studied Zewan C and D sequence represents the early to late part of the Changhsingian stage, from 40 to 5 m below the top of Zewan D member with bioturbation still evident in some limestone layers till 2 m above. No trace fossils could be recognized in the topmost 3 m beds of Zewan D due to their gliding related amalgamated structure. The widespread distribution of traces and their in situ nature will be useful for interpretation of the paleoecological and paleo-environmental conditions during the late Permian in the Guryul ravine of Kashmir.

TAT - 4.3

Paleogene and Neogene foraminiferal biostratigraphy, sedimentation and paleo-climatechange of the Assam-Arakan Basin, northeast India

(Kapesa Lokho and V.C. Tewari)

The study of Tertiary fossils with regard to their biostratigraphy and paleoenvironment in the Northeast India was continued. A total of 22 days field work in Manipur and Nagaland was carried out in some selected sections for detailed sampling and field data. A reconnaissance survey was also carried out in the border areas of Myanmar in Manipur (Fig. 32). Pilot sampling was done for checking of microfossils. During the field studies from the Barail Group microfossils, ichnofossils and fossil leave impressions were observed in the outcrops, and they were sampled. The rocks of the Barail Group form a series of continuous/discontinuous linear patches in the Kohima-Patkai folded zone, the inner belt of Disang and Barail. These are mostly confined to synclinal parts and occur topographically as mere capping on synclinal hills. In the present study area in Wokha district of Nagaland in the Schuppen Belt, the Laisong Formation is mainly composed of medium-to fine-grained sandstone with subordinate shale. The fossil assemblage includes both dicot and monocot leaves. The dicot leaves probably belong to the families Fabaceae and Lauraceae, however, the monocot ones belong to palms. All the dicot leaves have entire margin indicating tropical condition. The presence of several legume leaves indicates the influence of dry season and hence seasonality in the rainfall. The fossil assemblage overall indicates a warm and humid climate with seasonality in the rainfall. The study on the discovery of these fossil leave (Fig. 33) and the ichnofossil is presently under study.

Microgastropods, larger foraminifers and unidentified fish like teeth (Fig. 34) were recovered from the Disang Group of Manipur. The primary understanding of the yielded assemblage suggest a paleoenvironment of shallow marine of subtidal zone. Further processing of rock samples collected from the Disang Group of Eocene age, Barail Group of Oligocene age and Surma Group of Miocene age from Manipur and Nagaland is in process.

TAT - 4.4

Biotic investigations of Early Tertiary successions from NW Sub-Himalaya and western India with reference to India-Asia collision and faunal dispersals

(K. Kumar)

The study of Eocene vertebrates from the Himalayan and Peninsular Indian sections and their palaeo-

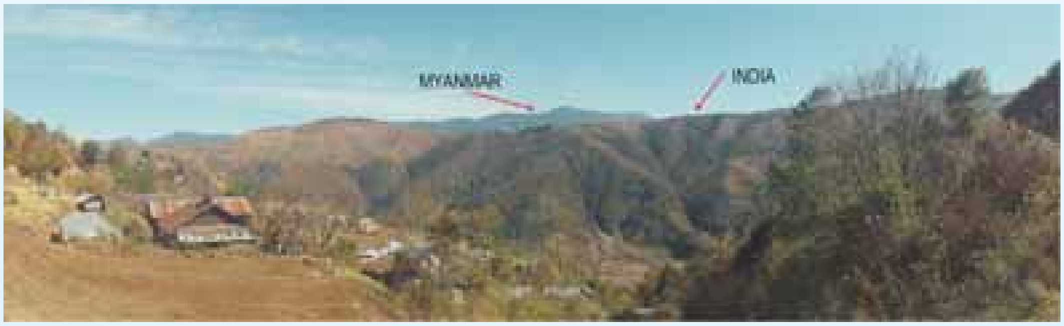

Fig. 32: Field Photo of an overview of the Ophiolite Belt in the Indo-Myanmar border, Manipur.

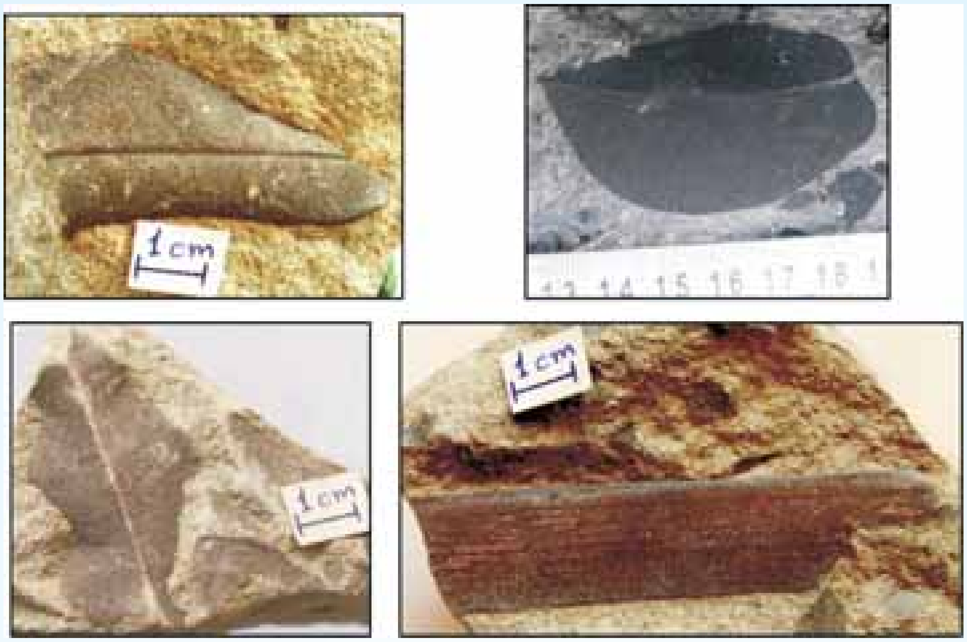

Fig. 33: Oligocene fossil leave impressions from Nagaland.

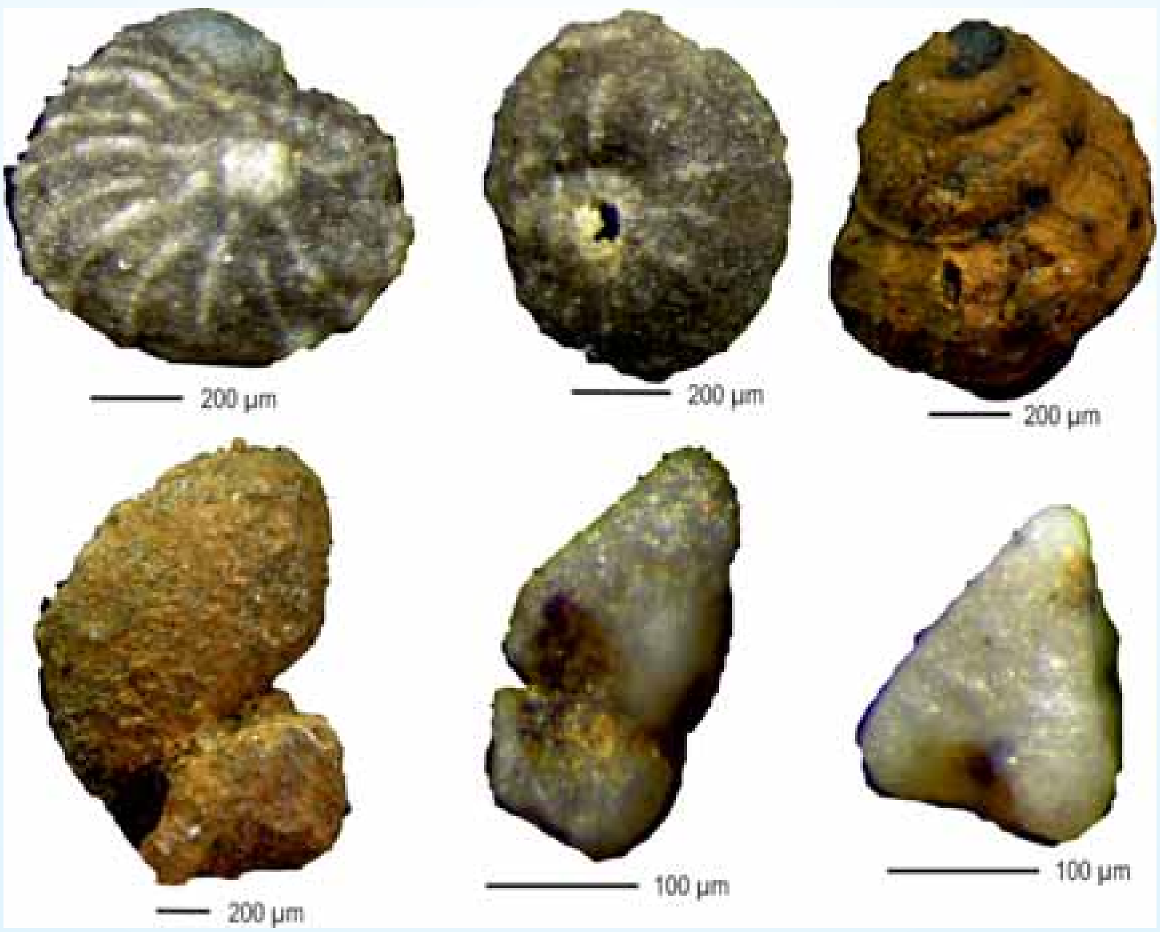

Fig. 34: Eocene larger forams, microgastropds and fish like teeth from Manipur.

geographic implications was continued. Vertebrates that received focus during the year include cambaytheres (Mammalia), which have most significant implications:

Perissodactyla is an extant mammalian order that appeared abruptly at the beginning of the Eocene across the Holarctic continents, with little indication of its source, although recent authors have favoured an Asian origin. Discovery over the last decade of very primitive cambaytheres in the early Eocene (~54-52 Ma) Cambay Shale Formation of Gujarat has confirmed that India played a significant role in the earliest radiations of Perissodactyla. A new sample of *Cambaytherium thewissi* is documented from the early Eocene Cambay Shale Formation of western peninsular India. It consists of more than 130 dental and gnathic specimens, including two skulls (Fig. 35), and nearly 100 postcranial bones (Figs. 36-38), which provide substantial new anatomical data indicating that *Cambaytherium* is morphologically intermediate between "condylarths" and Perissodactyla. Most anatomical features of *Cambaytherium* closely resemble those of basal perissodactyls such as *Homogalax*, *Arenahippus*, and *Protorohippus* (the latter two genera formerly included in *Hyracotherium*). Many features, however, are more plesiomorphic, often recalling the traits of phenacodontids. Derived cranio-dental traits that unequivocally link *Cambaytherium* with Perissodactyla include a transverse nasofrontal suture, fused mandibular symphysis, twinned lower molar metaconids, and a well-developed third lobe on the last lower molar (Fig. 35). In the postcranial skeleton, *Cambaytherium* and perissodactyls share an alternating tarsus in which the astragalus is deeply grooved and has a wide, saddle-shaped (concave) articulation for the navicular (the classic perissodactyl synapomorphy) and a narrow articulation with the cuboid (Figs. 37 and 38). Articular facets on Mt III indicate that the entocuneiform was rotated posterior to the second metatarsal (Mt II) so that the vestigial Mt I articulated with both the entocuneiform and Mt III, a condition unique to perissodactyls. In the forelimb, the humerus has moderately reduced epicondyles and lacks an entepicondylar foramen. In combination, these features occur only in Perissodactyla (Fig. 38). Together with these unmistakable perissodactyl traits, *Cambaytherium* retains many plesiomorphic features lost in perissodactyls but often present in phenacodontid condylarths. Overall, the anatomy of *Cambaytherium* indicates a more omnivorous diet and less cursorially adapted skeleton than in early perissodactyls. To investigate the phylogenetic position of cambaytheres, we conducted a parsimony analysis of 52 taxa and 208

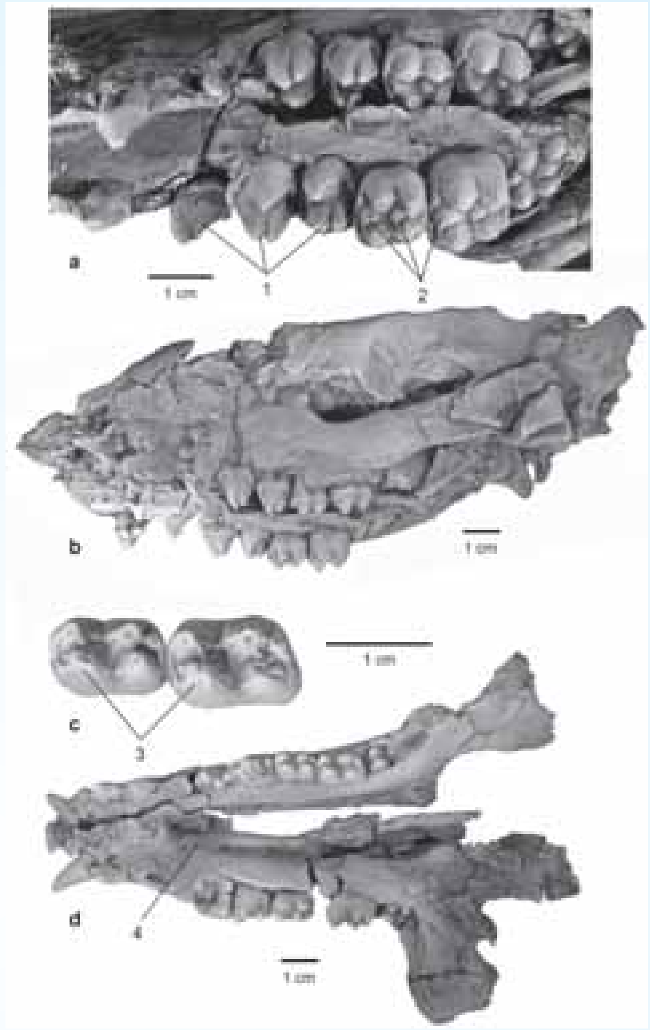

Fig. 35: Skull and mandible of *Cambaytherium thewissi.* a,b: Skull in lateral view, and c,d: mandible in dorsal (occlusal) view. c: Right M_{1-2}, enlarged. Key features include: 1: non-molariform premolars; 2: bunodont molars with large conules; 3: twinned molar metaconids; 4: fused symphysis.

morphological characters. The results support the hypothesis that cambaytheres are basal members of the clade including perissodactyls and are remnants on the Indian subcontinent of the earliest diversification of this clade. The results also support the identification of anthracobunids as closely related to Perissodactyla rather than Proboscidea. The presence of the sister group of perissodactyls in western India near or prior to the time of collision suggests that Perissodactyla may have originated on the Indian Plate during its final drift toward Asia (Nature Communications 2014).

Attempts to substantiate the collection of rodent remains from the crucial Late Paleocene-Early Eocene horizons of NW sub-Himalaya resulted in the recovery

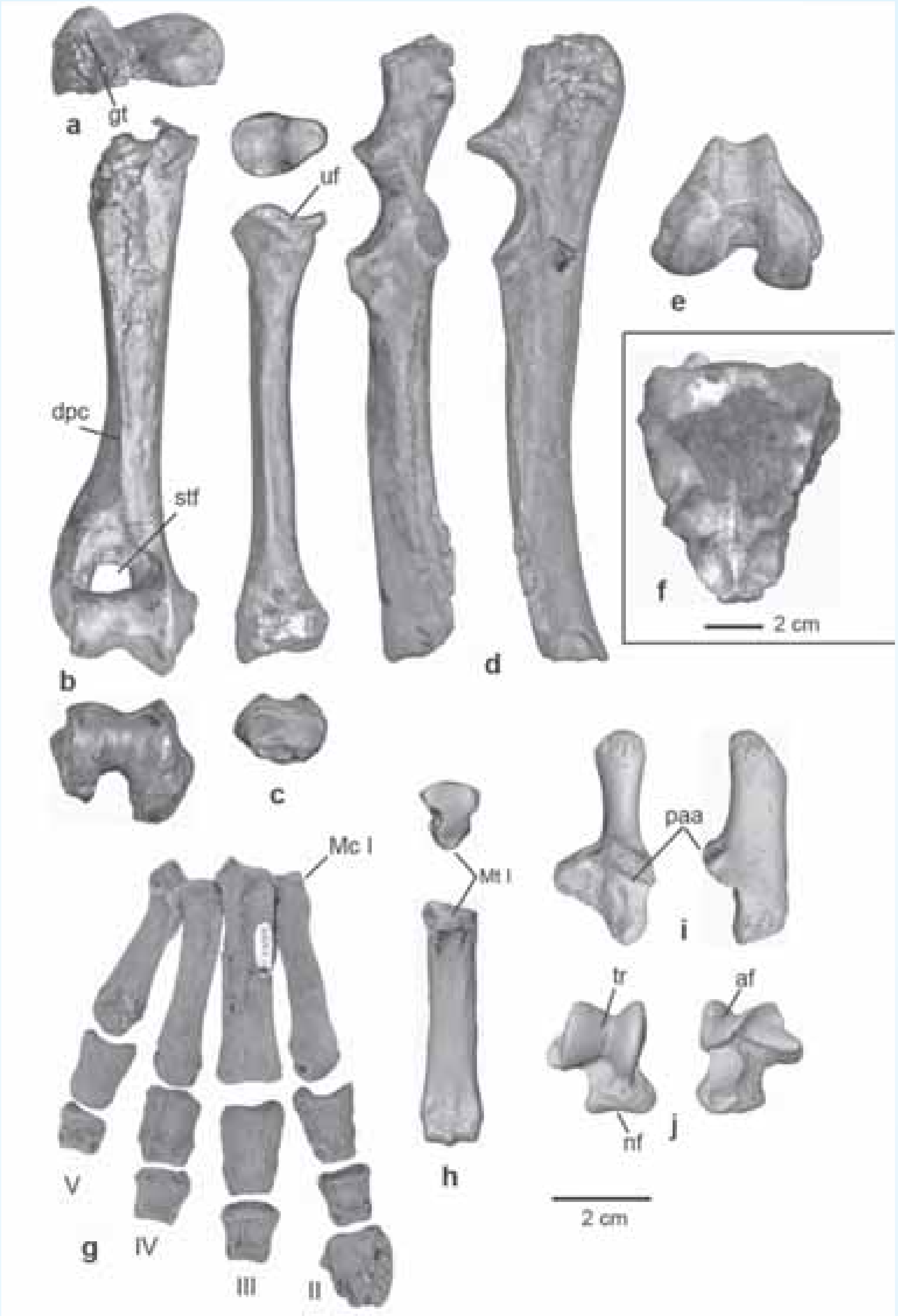

Fig. 36: Postcranial bones of *Cambaytherium thewissi* and cf. *Kalitherium* sp. a: Proximal right humerus (medial view). b: Distal right humerus (anterior and distal views). c: Right radius (proximal, posterior, distal views). d: Right ulna (anterior and medial views). e: Distal right femur. f: Sacrum (*Kalitherium*?). g: Reconstructed right manus (dorsal view of Mc II-V and phalanges, positions uncertain; multiple individuals). h: Left Mt III (proximal and posterior views). i: Left calcaneus (dorsal and lateral views). j: Right astragalus (dorsal and ventral views). Abbreviations: af: astragalar foramen; dpc: deltopectoral crest; gt: greater tuberosity; Mc I: facet on Mc II for first metacarpal; Mt I: facet on Mt III for vestigial Mt I; paa: posterior astragalar articulation; nf: navicular facet; stf: supratrochlear foramen; tr: trochlea; uf: ulnar facet.

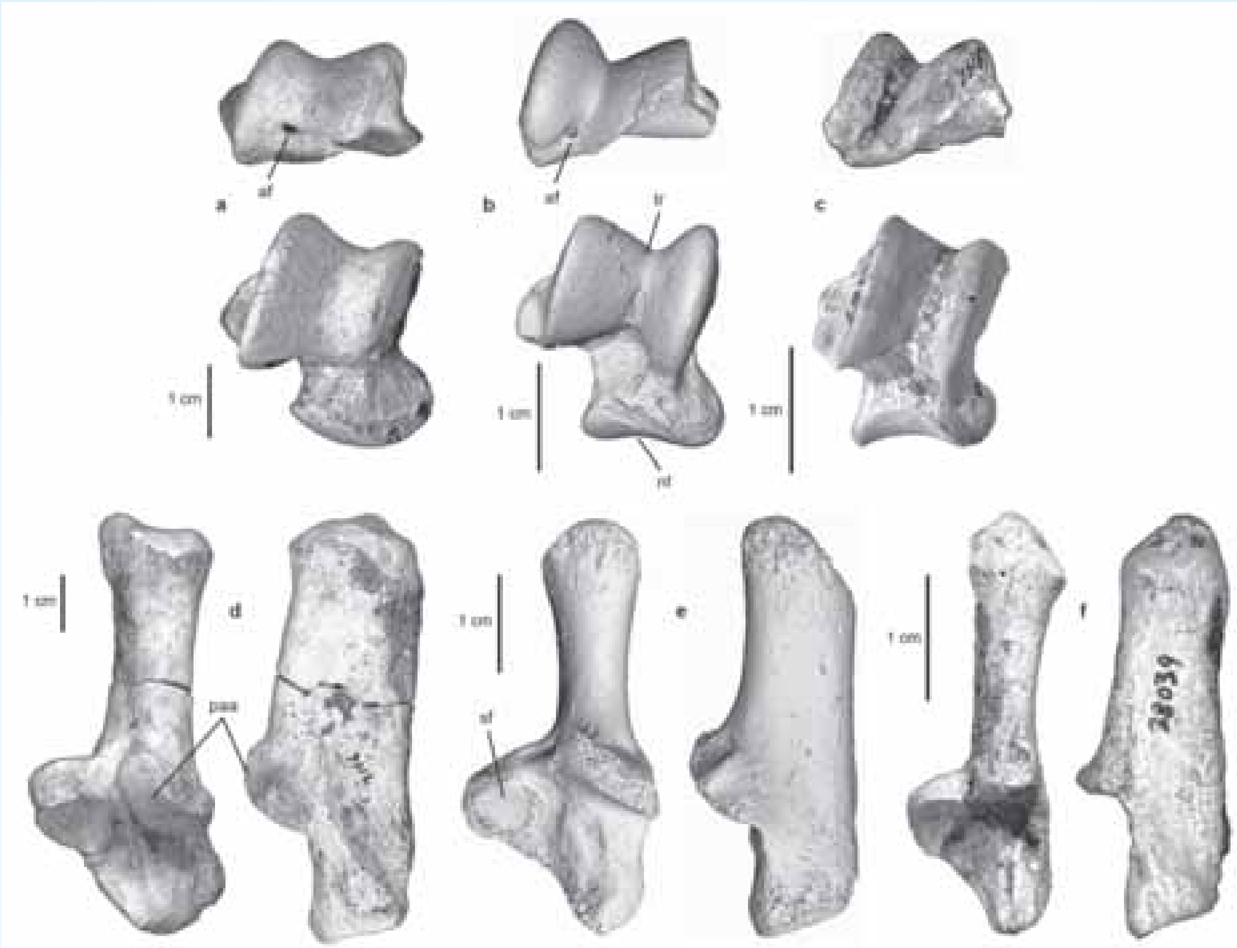

Fig. 37: Right astragali (posterior view "dorsal at top" and dorsal view) and left calcanei (dorsal and lateral views). a,d: *Phenacodus primaevus.* b,e: *Cambaytherium thewissi.* c,f: cf. *Arenahippus* sp. Each series scaled to same length. *Cambaytherium* shares several primitive traits with *Phenacodus* (not found in primitive perissodactyls), including a dorsal astragalar foramen, wide astragalar trochlea and longer neck, robust calcaneus with wider ectal and sustentacular facets, and a rounded ectal facet. Derived traits shared with perissodactyls include a deeper astragalar trochlea and concave navicular facet, though the latter is shallower than in perissodactyls. Abbreviations: af: astragalar foramen; nf: navicular facet; paa: posterior astragalar articulation; sf: sustentacular facet; tr: trochlea.

of additional rodent teeth. A detailed study of this material is presently underway.

TAT - 4.5

Vertebrate faunal studies of the Neogene Siwalik Group (NW Himalaya) with reference to migration history and Himalayan uplift

(R.K. Sehgal)

The studies related to vertebrate faunal studies of the Neogene Siwalik Group (NW Himalaya) with reference to migration history and Himalayan uplift were continued. A total of 18 days field work was carried out in the outer Himalaya of Jammu and Kashmir, Himachal Pradesh and Punjab. New fossil discoveries were made (mega-vertebrates) from the late Miocene Siwalik deposits of the Kangra valley. A 1200 m thick stratigraphic section was measured in the Jabbar Khad river, in the vicinity of Nurpur (Kangra). It was noticed that fossils are present only in basal 285 m of the section. The basal part of the section is characterized by thick red mudstone units, followed upward by sandstone-mudstone alterations and the top of the section is represented by conglomerates. Earlier the Nurpur succession was considered equivalent to the Lower Siwalik Subgroup, but with the reporting of the new fossil material, it was opined that the Nurpur succession is younger and it is equivalent to the Dhok Pathan Formation of the Middle Siwalik Subgroup. A geological map of the area was prepared and fossil localities were marked therein. A wide diversity of

Fig. 38: Left humeri in anterior view. a: *Phenacodus vortmani*. b: *Cambaytherium thewissi*. c: *Homogalax protapirinus*, to same scale. cap: capitulum; ct: capitular tail; dpc: deltopectoral crest; ent: entepicondyle; ent f: entepicondylar foramen; lat sup r: lateral supracondylar ridge; st for: supratrochlear foramen. Entepicondylar foramen (*Phenacodus* only), distally extensive deltopectoral crest, rounded capitulum, and prominent lateral supracondylar ridge are primitive traits. *Cambaytherium* and the primitive perissodactyl *Homogalax* are derived in losing the entepicondylar foramen, and *Homogalax* is further derived in being more elongate, with reduced deltopectoral and lateral supracondylar crests, and a conspicuous capitular tail.

mammalian fauna belonging to carnivore, tragulidae, suidae and giraffidae were described. The geological map incorporating fossil localities and some distinguished fossils are shown in figures 39 and 40, respectively. Besides discussing the systematic palaeontology of the mammalian fauna, an attempt was also made to interpret the intercontinental correlation of the Nurpur fauna. The distribution of the various genera of the Nurpur assemblage in equivalent horizons in the other parts of the world is presented in table 1, which shows that the Nurpur mammalian assemblage shares faunal elements with the Miocene localities in Europe, Africa, Turkey and central Asia.

Uplift and denudation of the Himalaya as evident from the Cenozoic mammalian faunas was also attempted. It is observed that till Lower Siwalik times the Himalaya was not a formidable barrier for the migration of the mammalian fauna across its width. It was during the Middle Siwalik times (10 Ma) the Himalaya started acting as a barrier for north-south migration of the fauna. It is also noticed that the bulk of the Siwalik fauna is non-endemic.

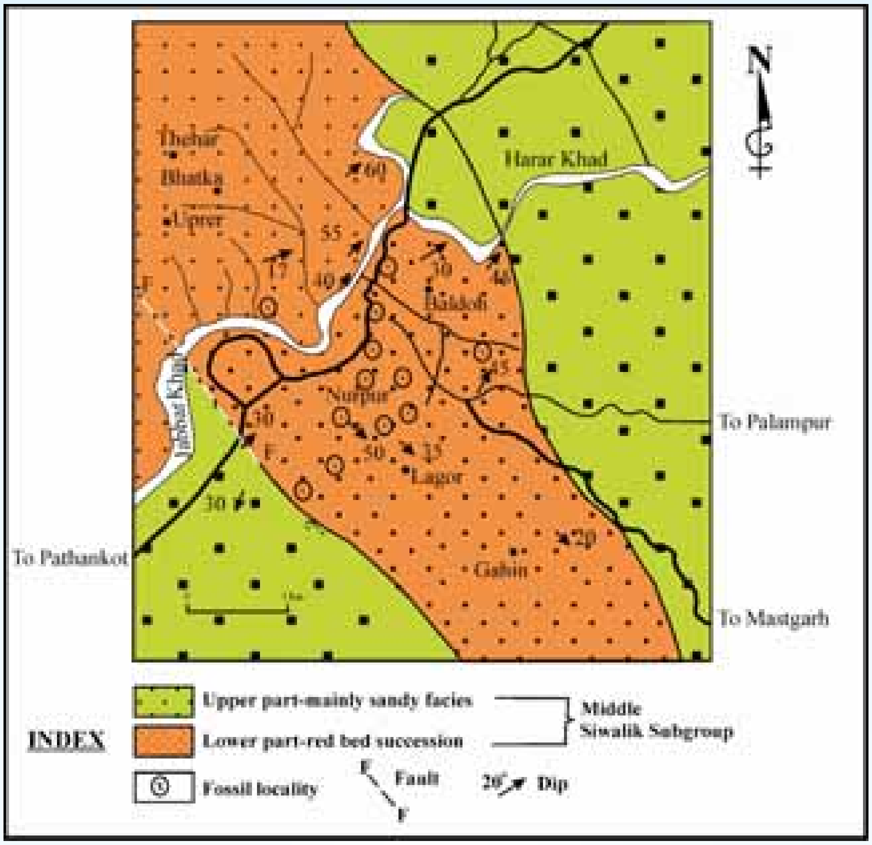

Fig. 39: Geological map of the Nurpur area.

Recently an elephant skull was recovered from Ganga Plains by Dr. P. Srivastava and his team. This skull was studied, and it was referred to *Elephas hysudricus*. The skull was systematically described and the palaeobiogeography of *E. hysudricus* was discussed. With the support of OSL dating and a stone tool, an age of ~56 Ka was estimated for the skull bearing horizon.

Very recently a rare hominoid fossil was discovered from the Lower Siwalik sediments of the Jammu region. The specimen is tentatively identified as *Sivapithecus simonsi*. The detail study is under way, and it can throw light on the phylogeny of the hominoids in the Siwalik Group. Also, new microvertebrates (especially rodents) were discovered from the Upper Siwalik sediments of

Table 1. Distribution of various mammalian genera of Nurpur Local Fauna in equivalent horizons in other parts of the world.

NURPUR LOCAL FAUNA (DHOK PATHAN FORMATION) (=TUROLIAN FAUNA) (after Vasishat *et al.* 1983; Gaur *et al.* 1985; Ranga Rao 1993; Sehgal & Nanda 2002b)	
Dissopsalis, Amphicyon, Deinotherium, Tetralophodon, Cormohipparion, Aceratherium, Gaindatherium, Hippopotamodon, Listriodon, Propotamochoerus, Tetraconodon, Anthracotherium, Merycopotamus, Dorcabune, Dorcatherium, Giraffokeryx, Hydaspitherium, Bramatherium, Protragocerus	EUROPE: **Amphicyon, Deinotherium, Tetralophodon, Cormohipparion, Aceratherium, *Gaindatherium, *Hippopotamodon, *Listriodon, Propotamochoerus, *Anthracotherium, Merycopotamus, Dorcatherium, *Giraffokeryx, Protragocerus*
	AFRICA: *Dissopsalis, Deinotherium, Cormohipparion, Aceratherium, Giraffokeryx, *Listriodon, Merycopotamus, *Dorcatherium, *Protragocerus*
	TURKEY: **Amphicyon, *Deinotherium, Tetralophodon, Cormohipparion, *Aceratherium, Hippopotamodon, *Listriodon, *Dorcatherium, *Giraffokeryx*
	CENTRAL ASIA: *Amphicyon, Deinotherium, Cormohipparion, Aceratherium, Hippopotamodon, *Listriodon, Propotamochoerus, Tetraconodon, *Anthracotherium, Dorcabune, *Dorcatherium, Hydaspitherium*

* Not present in Turolian, but known from older horizons

Patiali Rao section, District Ropar (Punjab) and are being studied.

To constrain the palaeoclimate and palaeoecology of the area, the carbon and oxygen stable isotope analysis of the calcrete and molluscan shells from the Upper Siwalik sediments were carried out in the Institute's Lab, along with the isotope analysis of fossil tooth enamel.

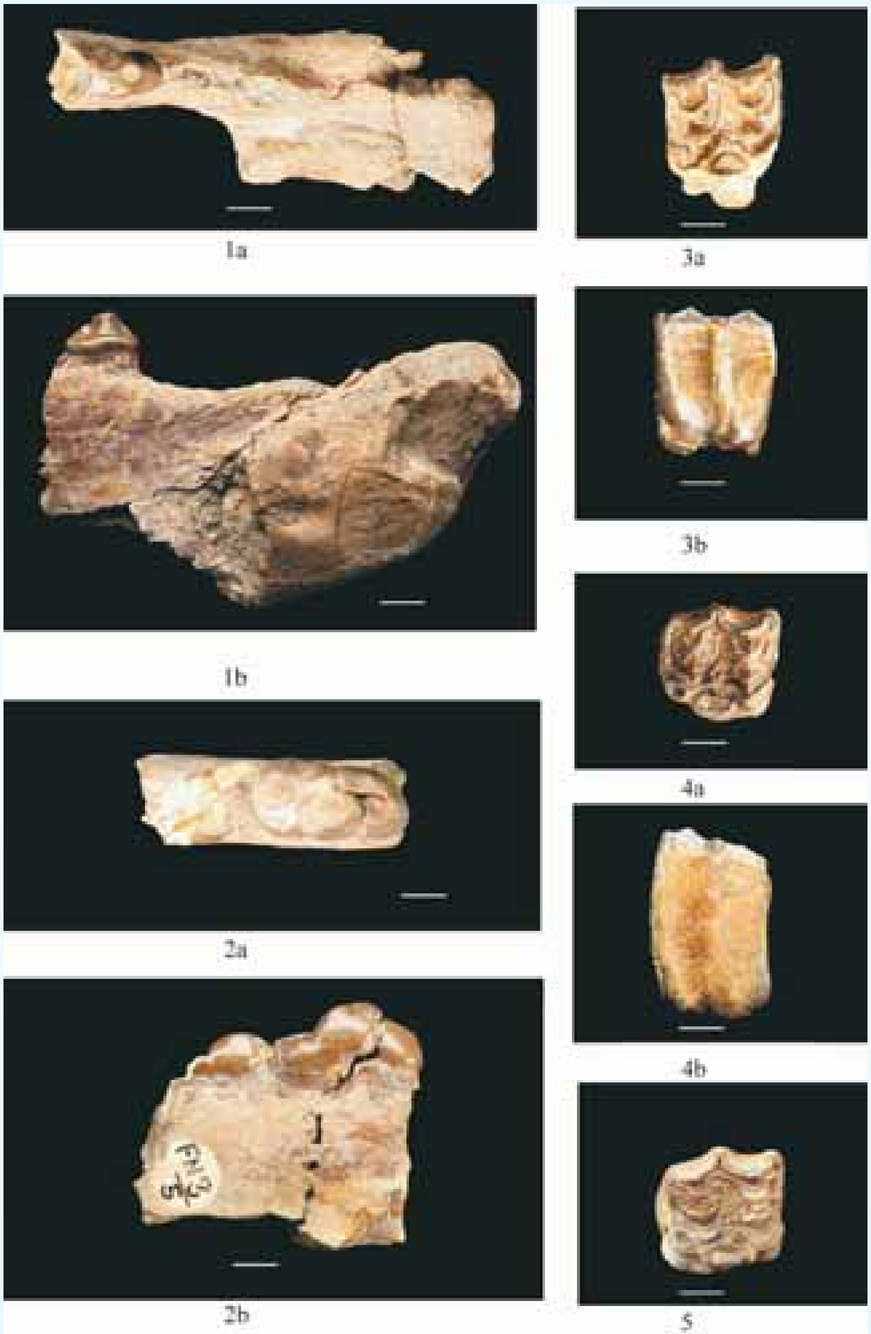

Fig. 40: (WIF/A 1403): Dissopsaliscarnifex, 1a: occlusal view; 1b: lateral view. 2: (WIF/A 1404): Amphicyonpalaeindicus, $LM_{1\text{-}2}$, 2a: occlusal view; 2b: lateral view. 3: (WIF/A 1415): Cormohippariontheobaldi, RM^1, 3a: occlusal view; 3b: buccal view. 4: (WIF/A 1416): Cormohippariontheobaldi, RM^2, 4a: occlusal view; 4b: buccal view. 5: (WIF/A 1417): Cormohippariontheobaldi, RM^1, 5: occlusal view (Scale bar represents 1 cm).

TAT- 5: HIMALAYAN GLACIERS: THEIR ROLE IN INDIAN MONSOON VARIABILITY AND HYDROLOGICAL CHANGES IN THE GANGA BASIN

TAT - 5.1
Mass balance and snout fluctuation studies of Dokriani and Chorabari glaciers, Garhwal Himalaya

(D.P. Dobhal)

The present work is a continuation of the ongoing long term glaciers monitoring programme on glaciers mass change in context to climate and water budget. The Dokriani (7.0 km^2) and Chorabari (6.6 km^2) glaciers located in the Bhagirathi and Alaknanda river basin, respectively, Garhwal Himalaya, are being monitored for the present study. In addition, influence of debris cover on surface melting of Dokriani Glacier was also performed. For the Chorabari Glacier, a physically based Surface Energy-Mass Balance model was developed including heat conduction analysis through debris layers. The model was developed using the near-surface meteorological data collected from Automatic Weather Station located in the upper ablation zone (4270 m asl) of the glacier.

Annual Mass Balance and Snout Retreat

It was risky to work over the glacier regime due to damage of the tracks and camping sites due to June 2013 flash flood in the Mandakini valley. The mass balance of Dokriani Glacier for the balance year 2013-2014 was carried out; however, the mass balance measurement of Chorabari Glacier could not be performed as the area was not accessible. The data of Dokriani Glacier on the winter snow accumulation and summer ablation were collected and analysed. The data have been collected as per international practice. The results represent that the glacier has continuous negative balance as recorded during previous years with net specific mass balance of -0.36 m w.e. The trend is slightly more negative than the balance year 2012-13 (-0.35 m w.e.). The equilibrium line altitude (ELA) was estimated from the field observation as well as vertical mass balance gradient and has been found at an elevation of 5090 m asl. The accumulation area ratio (AAR) was estimated to be ~0.66 during the study period. The snout of the glacier was monitored by GPS with reference to permanent survey point made on both the side of the glacier front. The total retreat determined was 21 m for the year 2013-14 (from November 2013 to October 2014). It is also observed that the results of snout retreat of Dokriani Glacier were comparatively more than the previous years (between 12-16 m/yr). The observed enhanced retreat may be due to the sudden breaking/plucking of snout by the physical processes controlling the dynamics of snout and adjoining area. Such processes have also been reported for other glaciers in the Himalaya. The detail results of the Dokriani Glacier studied is tabulated below:

Year	Net Balance (10^6m^{3}w.e.)	Specific Mass Balance (m w.e.)	ELA (m asl a.s.l.)	AAR	Frontal Retreat (m)	Snout Position (m asl)
2012-13	-2.36	-0.35	5090	0.672	12	3945
2013-14	-2.51	-0.36	5095	0.668	21	3975

Influence of debris cover on Glacier Surface Melting

Most of the glaciers in the Himalaya consist of debris covered ablation area with varying amounts and thickness on the surface of a glacier. The distribution and thickness of debris play an important role in surface melting processes, and thereby has influence on the glacier mass balance. In order to evaluate the influence of debris cover on surface melting, an attempt has been made to relate the varying debris cover thickness of Dokriani Glacier in the ablation zone (3.5 km^2). Six ablation stakes were used to calculate the melting on debris-covered and debris-free surface during the entire ablation period in 2013 and 2014. Results show significant difference in melting rate under the varying debris thickness. The melting obtained for 40 cm of thick debris-covered surface was 0.72 cm/day, which is lower than those obtained for clean ice and less debris-covered ice (Fig. 41). During the period, overall melting rate of 8.01 cm/day that was highest under >0.5 cm of debris cover compared to clean ice melting of 6.01 cm/day is observed. It was also observed that the temperature and precipitation has significant effects on the melting of clean ice and fine debris cover ice. However, the melting under thick debris was much influenced by amount of rainfall rather than by temperature. This is owing to the 10-25 mm of rainfall with an average temperature of 8-10°C. It significantly contributes its potential energy and enhances the ice melting under debris cover.

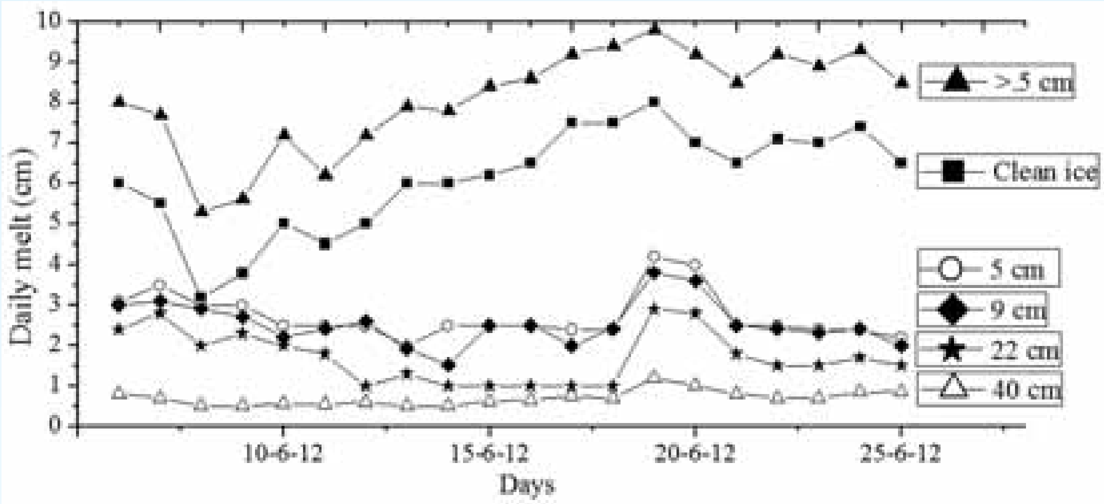

Fig. 41: Surface ice melting observed under debris covered and clean ice of Dokriani glacier.

Surface Energy-Mass Balance Modeling

Meteorological data collected from different Automatic Weather Station (AWS) observatories in the Chorabari and Dokriani glaciers are compiled and analysed. Based on available data, an attempt has been made to estimate the spatial and temporal variability of the surface ice melting (Energy Mass Balance) on the debris-covered ablation zone of the Chorabari Glacier for the year 2012-2013. The study provides a physically based, one-dimensional melt model derived from the collected meteorological variables. In addition, estimation of fresh snow accumulation occurred during the winter and summer (based on snow depth measurements) was performed for calibrating the total heat budget. The model calculates glacier surface melt rate including heat conduction through supra-glacial debris layer. Preliminary results indicate that during the summer, net radiation (R_n) of 46% was the largest contributor to the energy available for the surface melt (Q_M) followed by turbulent sensible heat flux (H_S) of 11%, latent heat flux (H_L) of 9% and heat flux due to precipitation (H_P) of 14%. It is also observed that subsurface heat flux (H_G) was the second largest contributor (~20%) after net radiation (R_n) to the total surface melt (Q_M) during the summer. Net shortwave radiation (S_n) was the most dominant energy flux to R_n , whereas net longwave radiation (L_n) made a negative contribution. The results also suggest that energy mass balance (EMB) at the glacier surface was highly influenced by the snow accumulation and supra-glacial debris characteristics (Fig. 42).

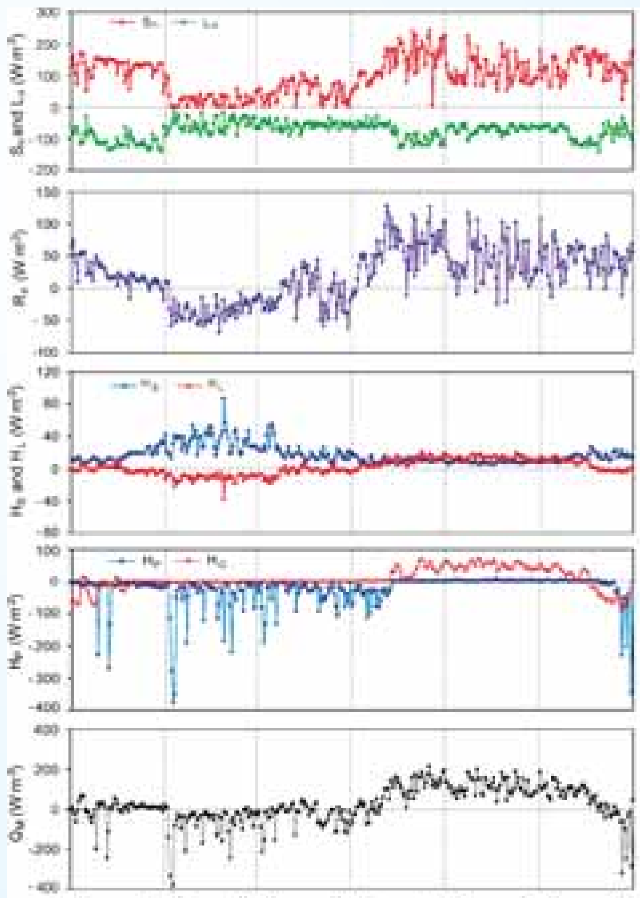

Fig. 42: Daily means of computed energy fluxex for Chorabari glacier during Nov. 01, 2011-Oct. 31, 2012.

TAT - 5.2
Assessment of potential hazards in the Glaciated regions: its causes and consequences

(Vikram Gupta, D.P. Dobhal and Swapnamita C. Vaideswaran)

The Gangotri catchment is highly glaciarised as the winter snow line fall down to about 2200 m asl. The valley is composed of loose unconsolidated glacier material between 2200 and 4000 m and is plagued by several hazards like rock-fall, debris flow and flood, particularly during summer period when the snow/ice melting is maximum coupled with the monsoon rains. Above 4000 m asl (present snout of the glacier), the area is mainly snow covered with ~10-15% permanent snow/ice cover, and with the presence of numerous glacial lakes. Considering the outburst hazard potential of the lakes, an attempt was made to map the glacier lakes in the Gangotri glacier catchment. The study was carried out with the help of satellite images for the years 2011-2013 having resolution of 5 m (LISS IV). A total of 135 glacier lakes (size >500 sq. m) have been identified, of these, 130 have been classified as ice-dammed lakes (supra-glacial lakes) and only 5 are moraine-dammed lakes. The supra-glacier lakes developed over the glacier surface where the debris thickness is quite favourable to store the glacier melt water are commonly considered to be unstable lake or hazardous lakes.

Landslide mapping has also been carried out in the lower reaches of the Bhagirathi valley around Uttarkashi township. It has been observed that in a stretch of about 28 km between Bhatwari and Uttarkashi, 23 active landslides were present. These are mainly deep seated planar debris slides. The dispositions of the landslides were well correlated with the river gradient and geological structures of the area. It has been noted that the river gradient in this stretch is highly variable ranging between 3.6 m/km to 66.6 m/km, and is marked by three major knick points. These knick points are well correlated with the disposition of thrusts and a fault present in the area, and in turn the presence of landslides. Based on these knick points, the entire area has been divided into four zones. The area between Bhatwari and Ganeshpur is marked to be the zone of transportation, and the area between Ganeshpur and Uttarkashi to be the zone of deposition of river sediments. It has been estimated that there is an average aggradation of about 0.5 m/year in the area around Uttarkashi. Further, it has been observed that huge volume of material deposited in the area around Uttarkashi township is posing serious threat to the slope stability on either banks of river.

TAT - 5.3
Hydrogeology of Himalayan springs

(S.K. Bartarya and Santosh K. Rai)

Hydro-geochemistry of hot water springs

In continuation of the study of hot springs in NW Himalaya, geothermal springs along the Indus and Nubra valleys of Ladakh region and Satluj and Beas valleys of Himachal region have been studied. The major and trace element characteristics along with stable isotopic compositions ($\delta^{13}C_{DIC}$, $\delta^{18}O$ and δD) of these springs were employed to trace their origin and process of metamorphic CO_2 degassing. Such information was also used to infer about the altitude effect of stable isotopes in the arid Himalaya. Surface temperatures of these springs varies from 21 to 95°C, with an average of 56°C, whereas pH ranges from slightly acidic to alkaline (6.2 to 8.9) with an average of 7. Hydrochemically these springs fall under the categories of HCO_3:Cl:SO_4 and Na+K:Mg:Ca types. Abundance of trace elements in these spring waters, such as Fe, B, Li, Sr, Mn, Al, Mo, Zn, and As, are found in considerable amount, possibly due to rock-water interaction. Springs of the study area contain high ratios of dissolved inorganic carbon (DIC) with concentrations of HCO_3^- ranging from 1300 to 13400 µE, (with average of 5297µE). The $^{13}C_{DIC}$ of these springs varies from -8.4 to +1.7‰ VPDB, which points towards the deeper source of their origin. The $\delta^{18}O$ composition of these springs range from -16 to -7.3‰ with corresponding variation in δD varies from -124 to -45‰ indicating mixing of thermal water with a meteoric dominated reservoir as most of these samples fall on the line defined by Local Mean Water Line (LMWL).

Degassing of CO_2 flux to atmosphere

As a part of the research programme on geothermal systems of the Himalaya, geochemical and isotopic composition ($\delta^{13}C_{DIC}$, $\delta^{18}O_{H2O}$ and δD_{H2O}) of thermal spring waters from Garhwal, Himachal and Ladakh were determined. This has enabled to retrieve valuable information about the origin of geothermal fluids and degassing of metamorphic CO_2 emanating through these springs. Our results with $\delta^{13}C_{DIC}$ in thermal springs from the Indian Himalaya provide evidence for CO_2 degassing along the major thrust zones. Carbon isotope measurements in dissolved inorganic carbon ($\delta^{13}C_{DIC}$) in the geothermal waters show a wide range of variation from -8.5 to +4.0‰ VPDB. The enriched $\delta^{13}C_{DIC}$

compositions are indicative of a process of degassing of volatiles from the region, which has been illustrated with suitable model. This model suggests that when degassing takes place, carbon isotopes fractionate and the degassed CO_2 becomes lighter leaving the remnant water enriched in $\delta^{13}C_{DIC}$. Such enriched $\delta^{13}C_{DIC}$ values have been found from several hot springs of the northwest Himalaya, which indicate their deeper/magmatic origin. These results are similar and consistent with observations from the central Nepal Himalaya. One of the interesting results from this study suggests that the thermal spring having the highest enriched $\delta^{13}C$ (Tapoban) has also elevated surface temperatures. Therefore, $\delta^{13}C$ values of thermal springs may be used as a proxy to depict their origin in terms of meteoric versus magmatic source. The thermal springs of Garhwal, Himachal and Ladakh regions, Northwest Himalaya have been extensively sampled and analysed for their major ions and carbon stable isotope composition. These measurements have led to the following observations and conclusion:

- Degassing of metamorphic CO_2 from the Himalayan region is one of the important contributors to the global carbon budget in the atmosphere.
- Isotopic compositions of dissolved inorganic carbon ($\delta^{13}C_{DIC}$) in the thermal spring waters of Garhwal, Himachal and Ladakh regions show a wide range of variation from -8.4 to +4.1‰. Such highly enriched values of $\delta^{13}C_{DIC}$ are indicative of metamorphic de-carbonation reaction for contributing CO_2 to the fluids.
- The metamorphic CO_2 flux from 40 thermal springs from the Northwest Himalaya is estimated to be ~2 $x10^8$ mol/year.
- CO_2 flux from the Northwest Himalaya is higher by two orders of magnitude compared to the Tibetan plateau.
- Combining all the studies in the Himalayan region (NW Himalaya, Nepal Himalaya and Southern Tibet region), a total CO_2 degassing flux of ~$2x10^{10}$ mol/year could be assigned.

TAT - 5.4

Geochemical investigation of stream and soil sediments of piedmont regions/plane south of Kumaun Siwalik Himalaya

(P.P. Khanna, N.K. Saini and R. slam)

Major and trace elemental characteristics of stream sediments of Udham Singh Nagar showed wide variations all along the studied area. As the piedmont regions show wide variations, it is difficult to identify their dominant contributing provenance or lithounits based on major and trace elemental abundances alone. An attempt was therefore made to use REE geochemistry tools to further characterize the source of soil and stream sediments in this area. Representate samples (15) of the piedmont transverse stream sediments of the studied area were analysed for their rare earth element concentrations. The samples are characterized by a nearly flat HREE ((Gd/Yb) 1.29 to 2.11) and moderately fractionated LREE pattern $(La/Sm)_N$ 3.75 to 4.13) with a moderate negative Eu anomaly (Fig. 43). Barring couple of low REE isolated samples, REE abundances are relatively uniform with ΣREEs ranging between 122 and 221ppm. The moderate range of Eu-anomaly (Eu/Eu*= 0.48 to 0.66), fractionated LREEs and high $(La/Yb)_N$ ratios ($(La/Yb)_N$ =8.1 to 13.8) of the stream sediment samples together

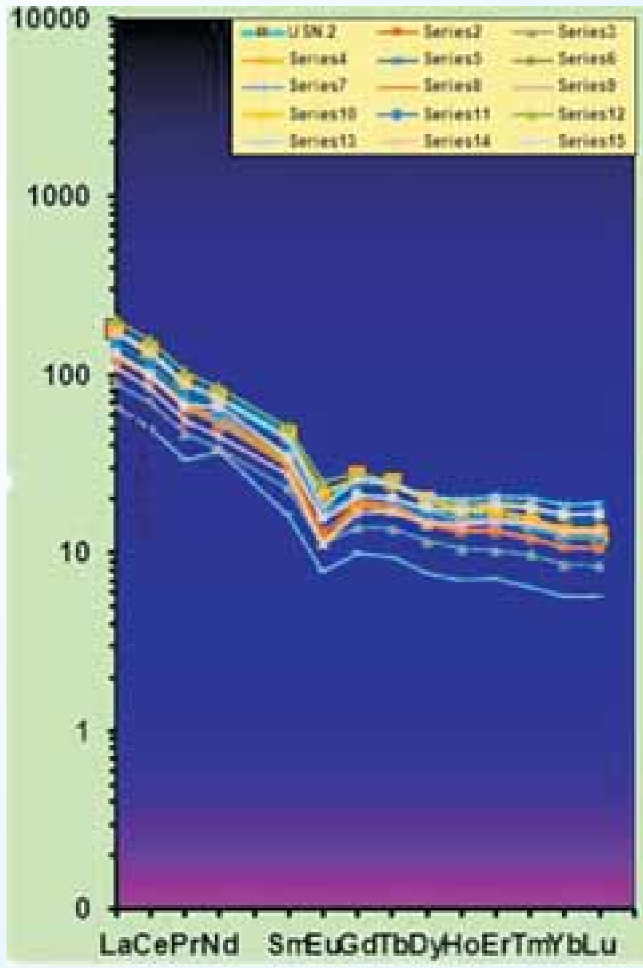

Fig. 43: Chondrite (C1) normalised REE patterns for the soil and stream sediments from Udham Singh Nagar area showing typical flat HREEs and fractionacetd LREE pattern.

with major and trace elemental characteristics sugget dominant contribution from felsic source.

Though the effect of proximal Bhawali-Bhimtal mafic lithounits is clearly visible in variation maps of Ca, Mg, Fe and Ti, it is not very distinguishable in REE patterns. Siwalik hill ranges being in the proximity, the obvious provenance for the piedmont stream sediments and the Siwalik sediments in turn herald its source in the Lesser and the Higher Himalayan lithounits. However, the felsic lithounits are predominately reflected in the geochemical landscape of the piedmont regions of the Kumaun Himalaya. Mafic contributions from Bhawali-Bhimtal volcanics are reaching to the central part of piedmont area through antecedent river system such as Gola river cutting through the Siwalik barrier.

Climatic influence on the stream sediments and on the source rocks are generally reflected in their chemical compositions due to weathering of the silicate to clay minerals. The chemical index of alteration (CIA) and chemical index of weathering (CIW) of Udham Singh Nagar sediments range between 36 and 69 (average=55.4) and 40 and 83 (average = 64.6), respectively, which indicate low to moderate weathering conditions. Correlation coefficient of Al with Ni, Cu, Zn and Fe is high and statistically significant. This is suggestive of association of these elements with clay fractions and show inherent relation with alumina-rich silicate phase particularly clays.

Though this area has seen tremendous industrial activity for last couple of decades, our study suggests no appreciable and detectable degradation of the surface environment. A comprehensive geochemical datbase of the studied area is now available allowing us to reasonably define base line with respect to which the future environmental changes can be quantified.

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DST-SERC Fast Track Project

Mineralization and petrogenesis of mantle sequence and cumulates of the Manipur Ophiolite Complex, Indo-Myanmar Orogenic Belt, NE India

(A. Krishnakanta Singh)

The Nagaland-Manipur Ophiolitites (NMO) form part of the Tethyan ophiolites and occur as a narrow belt. Although the NMO has a good exposure of ultramafic cumulates and tectonite-peridotites, no studies have been done on petrology and geochemistry of these components. Thus petrological and geochemical data including platinum group elemental (PGE) chemistry on cumulate pyroxenites and tectonite-peridotites from the NMO to understand their genesis and possible tectonic environment.

The tectonite-peridotites are distinguished from the cumulate pyroxenites by the presence of lineation, deformed bands and strained extinction in olivine, kink twin lamellae in pyroxene and higher abundance of Cr-spinel. The cumulate pyroxenites have higher Cr and lower Ni and their chondrite normalised REE patterns exhibit nearly flat MREE to HREE (Sm_N/Yb_N = 0.62-0.76) with depleted LREE (La_N/Sm_N = 0.38-0.76), whereas tectonite-peridotites show gradual decrease in concentrations from MREE to HREE (Sm_N/Yb_N = 0.29-0.46) and slightly increase in LREE (La_N/Sm_N = 0.72-2.20). The tectonite-peridotites have olivine (Fo_{89-90}), orthopyroxene (En_{82-90}), clinopyroxene (Wo_{44-49} En_{48-52} Fs_{3-5}) and Cr-spinel (Cr# = 0.11-0.27; Al# = 0.69-0.85) whereas the cumulate pyroxenites contain olivine (Fo_{85-87}), orthopyroxene (En_{86-88}), clinopyroxene ($Wo_{48-51}En_{44-49}Fs_{3-6}$) and Cr-spinel (Cr# = 0.27-0.48; Al# = 0.45-0.66). The cumulate pyroxenites show strong enriched PPGE patterns and higher PGE concentrations (ΣPGE = 86-163 ppb) compare to the tectonite-peridotites (ΣPGE = 35-113 ppb). The estimated equilibration temperature ranges from 890 to 931^{o}C for cumulate pyroxenites and 971 to 1156^{o}C for tectonite-peridotites. Mineral chemistry along with PGE characteristics indicates that the tectonite-peridotites are residual mantle after limited extraction of basaltic melts. Conversely, presence of highly magnesian orthopyroxene and clinopyroxene in the cumulate pyroxenites in conjunction with their geothermometry suggest that they were formed at high pressure and temperature in the form of deeply originated cumulates after magmatic fractionation. The geochemical data together with field and petrographical evidences indicate that both the tectonite-peridotites and cumulate pyroxenites are essentially spinel-bearing, and free from any plagioclase, suggesting their derivation from deeper source in the mantle beyond the stability limit of plagioclase in a mid-oceanic ridge tectonic setting. It is envisaged that the mantle section in the NMO was initially generated in seafloor spreading regime between Indian plate and Myanmar plate and subsequently thrusted over the continental margin during the collisional stage of these two plates.

The present investigation also attempt to study the carbonates that occur in the ophiolitic mélange zone of Manipur ophiolite complex. The carbonates show variable contents of REE ranging from 14 to 82 ppm with an average of 51 ppm which is higher than the average value of typical marine canbonate (~28 ppm). The increase in negative $\delta^{18}O$ and positive $\delta^{13}C$ values may reflect either increasing temperature or influx of meteoric water. The observed shale normalized positive Eu anomalies, negative Ce anomalies and spread in negative $\delta^{18}O$ to a lesser extent of $\delta^{13}C$ values of these carbonates suggest that their formation was affected by diagenesis in shallow marine environment. The studies suggest that these carbonates form part of the ophiolitic mélange zone that had emplaced during subduction and obduction processes of the Indian plate and Myanmar plate collision.

Project

Geodynamic evolution of the Indian Plate through high resolution Geoid/Gravity from SARAL/ALTIKA altimeter

(S. Rajesh, T. J. Majumdar, SAC/ISRO)

The main focus of the project is to study the geodynamic evolution of the Indian plate using high resolution geoid/gravity data obtained from SARAL/ALTIKA radar altimeter data. One of the main objectives is to understand how the marine data, including bathymetry, satellite gravity, geoid, regional seismicity and lithospheric age from the northwestern Indian Ocean can be used to ascertain the past kinematics of the Indian Plate. As has been observed that, in the past, the Indian Plate experienced variable levels of ridge push force and the slab pull force at its erstwhile divergent and the convergent margins, respectively. Past variable convergence rates of the plate can be sampled from the observed plate divergence rates and hence can be used as a proxy to find when the onset of continental-continental collision between Indian Plate and the Eurasian Plate had initiated, and how long the initial vigour of collision process was continued. The preliminary results show the initial vigour of the collision process was decayed from 52 to 32 Ma. We experimented this, further with the new SARAL Interim Geophysical Data Record (IGDR) downloaded from the ISRO ftp site during the month of August 2013. The available IGDR data from April 2013 to January 2014 were collected. The April 2013 file consists of both ISRO and CNES, IGDR-IPN files of cycle 2 and up to 251th pass of the cycle 3. The IGDR native format data were collected up to 10th cycle and 251st pass in the NetCdf format.

An optimum classical geoid data using SARAL along the track corrected SSH anomaly over the region has been deployed. The nearest neighbourhood statistics have been applied to find the optimum grid. The data range covers from 55 to 80^{o}E and 0 to 25^{o}N. The spatial grid spacing is roughly 28 km x 28 km. The gridded spatial resolution is around 28 km which is much less than the along track resolution of 8 km. The resultant SARAL geoid data has been used to compare with the best available model geoid from the Earth Gravity Model 96 (EGM96). The EGM96 anomaly has been computed up to the harmonic degree and order 360. For the comparison with SARAL derived geoid the model anomalies are computed at exact spatial grid as that of the SARAL geoid data and of the same geographical coordinates. The RMSE of SARAL classical geoid with respect to the EGM96 model geoid varies from 0 to 225 m. In general, SARAL derived geoid is in near perfect match with the model geoid, especially over the oceanic regions. Thus over the region of interest in the oceanic area the error in the SARAL geoid with respect to the model geoid is fairly good and at an acceptable level of ±8 m. We have also developed a methodology to find the ocean basal heat flux anomalies by using the observed geoid data.

MoES Project

VSAT linked Seismic Network for Seismic Hazard studies in Garhwal Himalaya

(Ajay Paul)

A seismic network of 10 Broad Band Seismograph (BBS) equipped with Trillium-240 (broadband) seismometer of high dynamic range (>138 dB) and Taurus data acquisition system (DAS) along with VSAT connectivity to Headquarter at Dehradun were installed, 7 in Uttarakhand, 2 in Himachal, and 1 in Uttar Pradesh. The data is being acquired on-line and analysed continuously. Till March 2015, a total of 28,333 events were detected which includes 4,737 local events, 12,879 regional events and 10,717 teleseismic events. The events recorded for the period between April 2014 and March 2015 are 862 (local), 2,653 (regional) and 2,863 (teleseismic).

The space time pattern are regularly being examined to demarcate the zones of enhanced/ quiescence that invariably precede the large earthquakes in this region. The striking feature of seismicity in the Kumaun-Garhwal Himalaya is the narrow belt of seismicity that follows trend of the MCT zone extending throughout the study region.

The spatio-temporal behaviour and the fractal dimension (Dc) of the seismicity of Garhwal region have been analysed using the earthquake data recorded by the network during 2007-2013. The b-value analysis under Entire Magnitude Range (EMR) method has been adopted to study spatio-temporal behaviour of seismicity, while the fractal dimension (Dc) for the seismicity of the region has been calculated using correlation integral method. The maximum probability estimates for whole region provides the b-value as 1.05±0.05. A significant spatial variation is observed in b-value for Garhwal region where the value varies in three different spatial domains as 1.42±0.2, 0.97±0.08 and 1.17±0.13 from the northwest Garhwal towards the Kumaun region with the central portion (block B) showing less b-value in comparison to the other regions (Fig. 44).

The temporal b-value has been observed to increase after the Kharsali earthquake of 22nd July 2007, with a significant lowering of the earthquake magnitude levels in the region, and similar decrease is observed in 2009. The b-value shows a decrease from 1.3±0.1 (for the July 2007-August 2010 period) to 0.86±0.08 (for the September 2010 - November 2013 period). The periods before and after the drop in b-value in the study area are marked by earthquakes of significant magnitude (Fig. 45). The fractal dimension analysis indicates the clustering of seismicity. The inferences based on spatial and temporal variation indicate the relative increase in recent seismic activity in the region of northwest Garhwal and Kumaun Himalaya. The low b-value estimates for the region of southeast Garhwal probably indicate accumulation of high stresses in the region.

In order to understand the crustal properties of Garhwal Himalaya, frequency-dependent attenuation

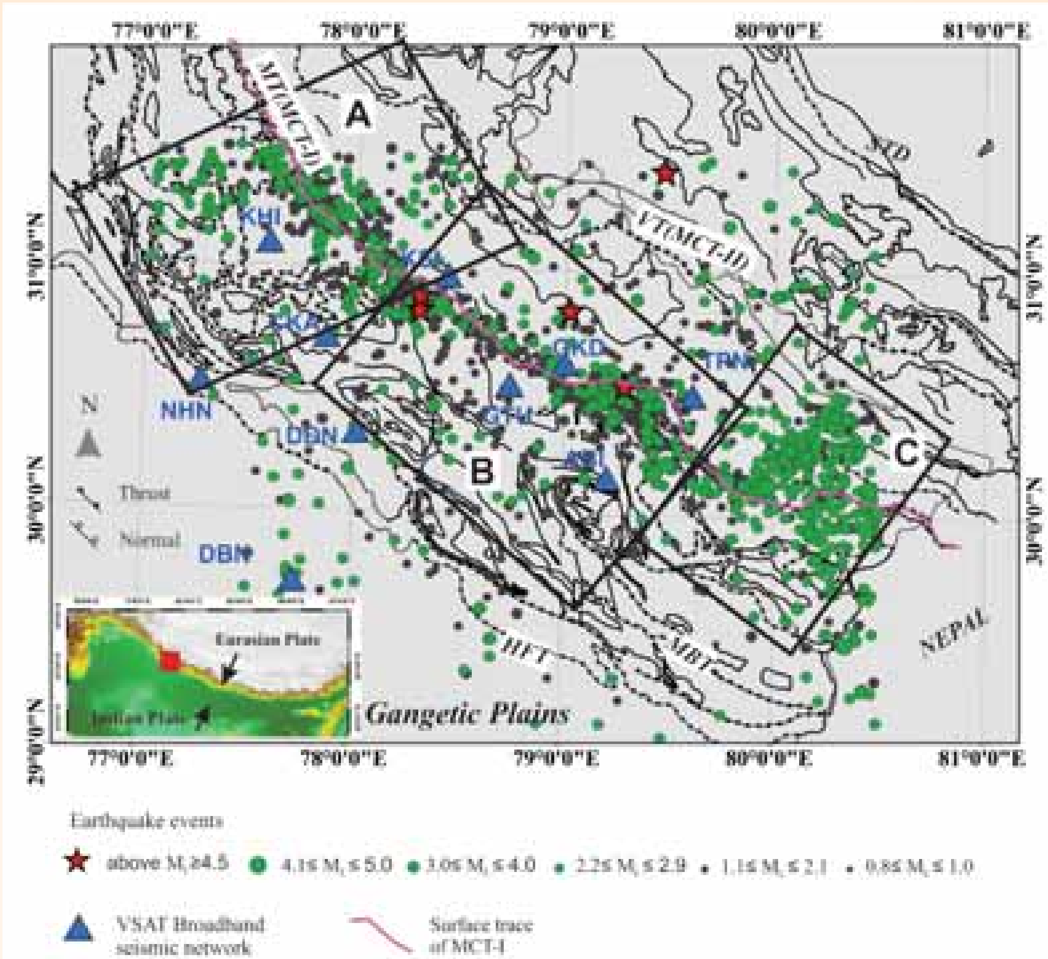

Fig. 44: Spatial distribution of the epicentres of the earthquakes on the tectonic map of Garhwal-Kumaun Himalaya (Modified after Thakur & Rawat 1992). The inset shows the location of the study area in India. The solid rectangles indicates the study region A (northwest Garhwal), B (southeast Garhwal) and C (Kumaun). The star (red) shows the earthquakes $M_L \geq 4.5$ in the region.

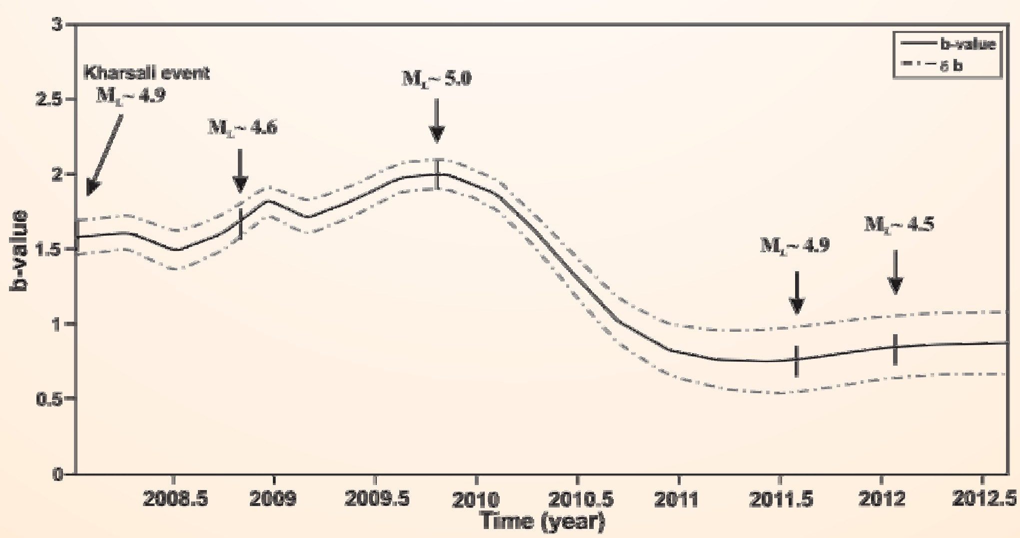

Fig. 45: The plot shows the b-value with time. The arrow shows significant light earthquakes $M_L \geq 4.5$ recorded in the study region.

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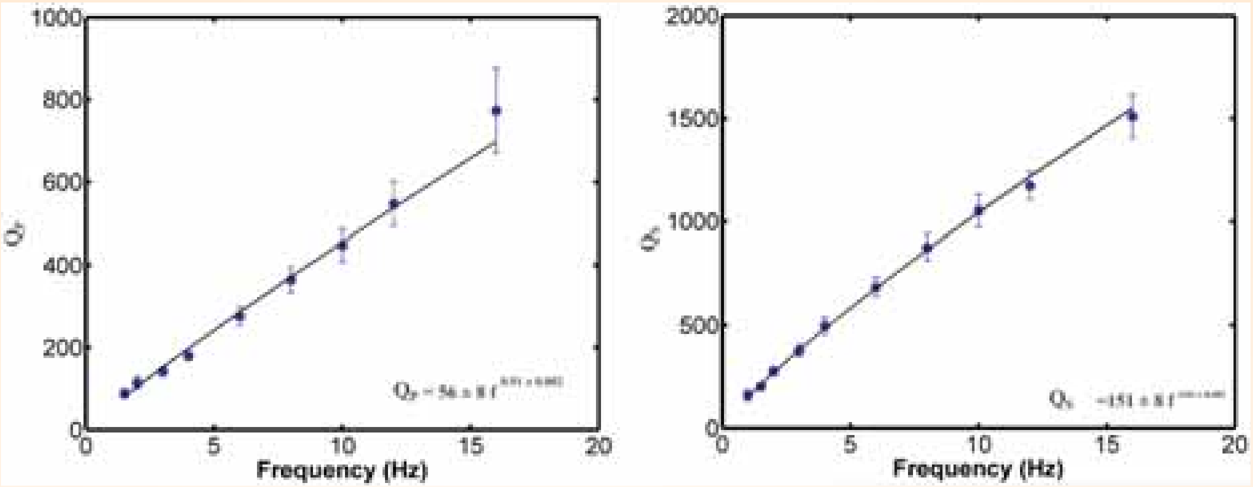

Fig. 46: Plots of mean value of Q_P and Q_S against frequency, for the Garhwal Himalaya. A power law in the form $Q=Q_o f^n$ is fitted. Vertical lines show the standard error bars.

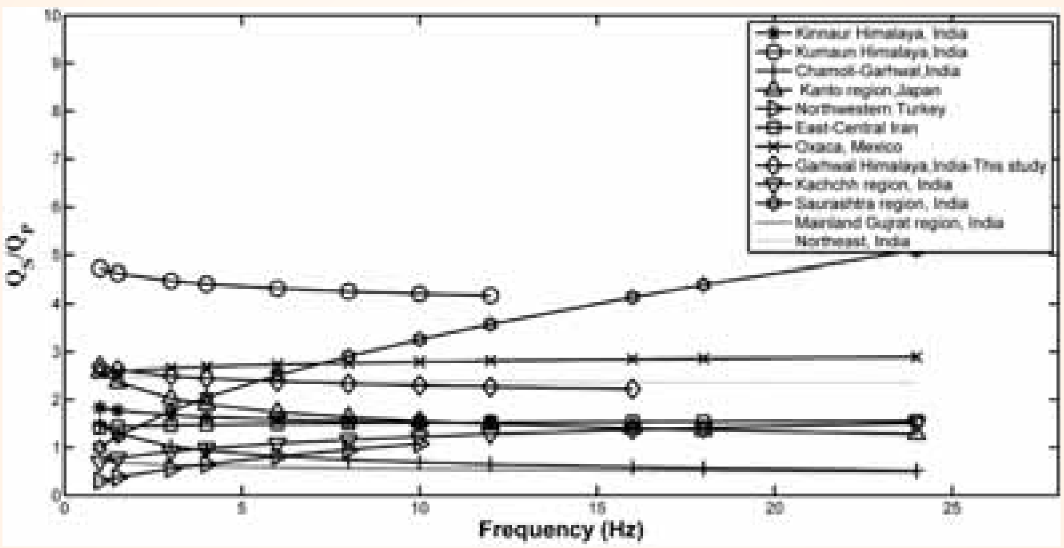

Fig. 47: The figure shows the global comparison plot of Q_S/Q_P for the Garhwal Himalaya for entire range of frequency.

characteristics of body waves (P and S) have also been studied. The quality factors Qp and Qs values indicating the inverse of the frequency dependent attenuation have been estimated using the extended coda normalization method. This study has been performed using 40 well-located local earthquakes, recorded by the network during 2007 to 2012, and by using the fitting a power-law frequency dependence model the Q_P (=56± $8f^{0.91\pm0.002}$) and Q_S (= 151 ± $8f^{0.84\pm0.002}$) values are obtained for the whole region (Fig. 46). The Q_P and Q_S results indicate a strong attenuation in the crust of the Garhwal Himalaya. It is observed that P waves are attenuated more strongly than S waves (i.e., $Q_S/Q_P>1$) for the entire frequency range, which suggests that, the scattering loss is due to a random and high degree of heterogeneities in the earth medium that is playing an important role in seismic wave attenuation in the Himalayan crust. The comparison plot (Fig. 47) shows that the Kumaun region is more heterogeneous and less stable compared with the Garhwal Himalaya.

Indo-Austrian collaborative Project

Evolution of marine Triassic biota and carbon cycle: from the Alps to the Himalaya

(S.K. Parcha)

The study area is located on the northern margin of Gondwana during late Paleozoic and hence along the southern side of the Neo-tethys Ocean at a paleo-altitude of ~35°S. The study section was measured bed by bed, and measurements were made relative to the lithological boundary that separates the Zewan and Khunamuh formations, i.e., the contact between units D and E of Nakazawa et al., which is easily identified in outcrop. The contact separates the first dark-gray shales of the Khunamuh Formation from the underlying sandstones and limestones of the Zewan Formation, although the uppermost bioclastic Zewan limestone is lithologically indistinguishable from the bioclastic limestone interbedded with the basal Khunamuh shales.

***The Permian-Triassic boundary beds*:** The uppermost 5 m of the Zewan Formation (Unit D, Beds 43-45) consist of bioturbated, fine- to medium- grained, well-sorted, argillaceous sandy limestones or calcareous shaly quartz sandstones with minor shaly interbeds (Fig. 48). The uppermost bed of the Zewan Formation (bed 32) comprises three layers (Fig. 48):

- A basal layer, ~8 cm thick, consists of weathered irregularly cross-laminated, sandy, ostracod-bearing

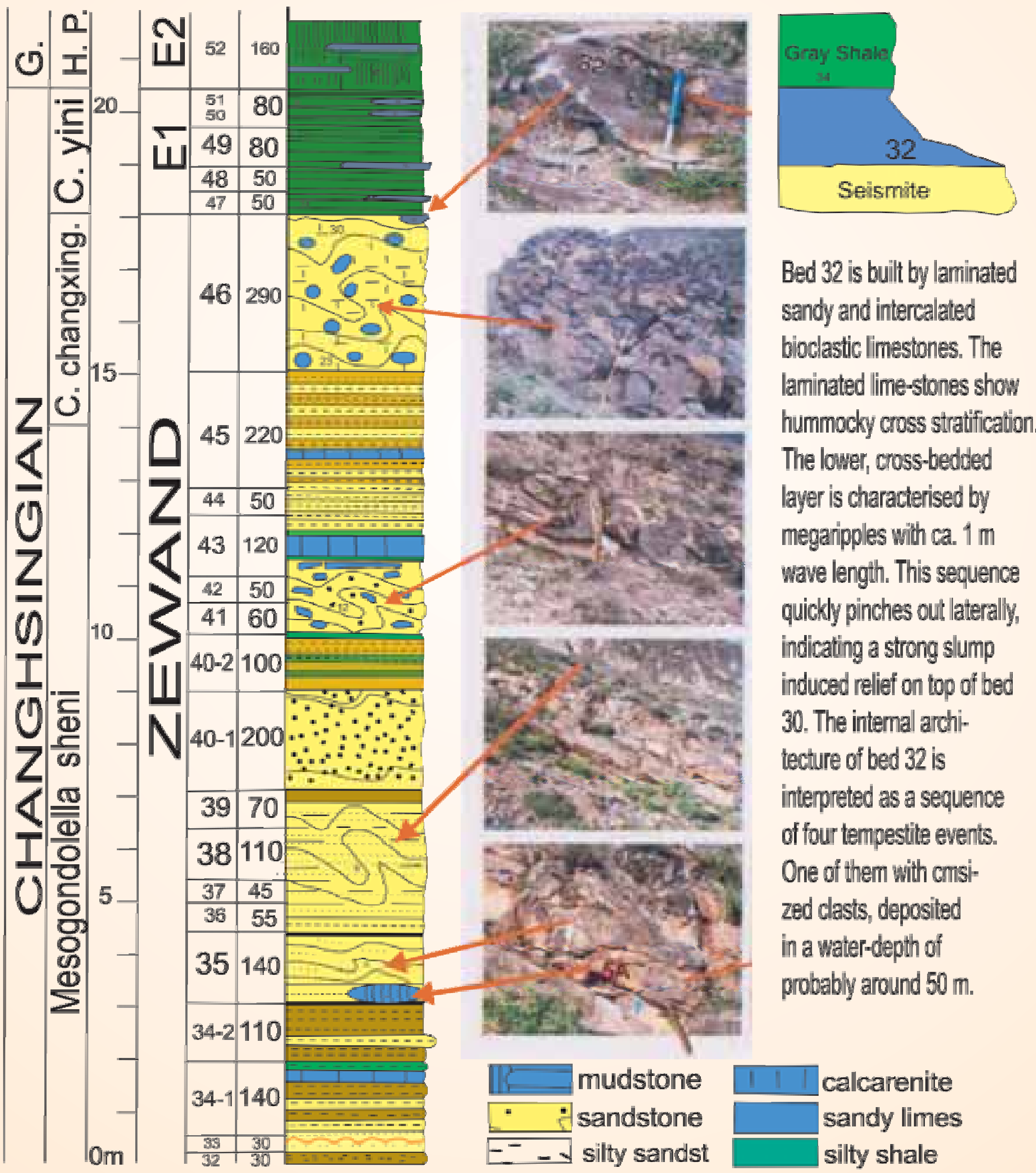

Fig. 48: Modified lithology after Nakazawa et al. 1981.

bioclastic limestone (grainstone). Unidirectional slumping in parts of the section suggests sediment deposition in a slope setting, with soft sediment deformation possibly triggered by storm waves or earthquakes. The basal layer has features suggestive of a composite shell bed formed by shell accumulation and reworking, including intraformational rip-up-clasts and complex internal erosion surfaces.

- A ~15 cm thick layer above the basal layer consists of parallel-laminated, well-sorted, fine-grained, micaceous, calcareous quartz sandstone with no identifiable fossils.
- A ~15 cm thick layer consists of irregular bioclastic lenses with large-scale cross-bedding and a hummocky top typical of storm deposits.

The overlying Khunamuh Formation exhibits a pronounced change in lithology. Its basal unit E1 is a 2.5 m thick transitional unit dominated by silty gray calcareous mudstones with subordinate thin interbeds of fine-grained quartz siltstones and fossiliferous limestones (Fig. 48). It is mostly laminated or micro cross-bedded with no signs of bioturbation. Unit E1 contain rare fossils, mostly brachiopods (especially Strophomenida) and small bivalves as stunted forms. Up section within Unit E1, sediments become darker, less quartz-rich, and more argillaceous, limestone beds become thinner and disappear, and the fauna changes from a relatively shallow-water assemblage composed of brachiopods and thick-shelled bivalves to one dominated by thin deeper-water pelagic bivalves. These changes reflect a substantial increase in relative water depth during the latest Permian towards the earliest Triassic.

No tsunamites in Guryul Ravine : *Earlier Brookfield* et al. claim at least three tsunami events correspoding to beds 32, 34 and 36, which they relate to shock waves induced by the Siberian traps eruptions. However, we disagree with them, because identical storm generated carbonate beds occur not only during a short interval close to the Permian-Triassic (P-T) boundary but through a major part of the late Permian (Changhsingian) succession there, as low as 26 m below the so-called tsunami beds (Fig. 48). Moreover, during our recent study less than 10 km to the SE in a closely neighbouring place called Mandakpal no signs of tsunamites have been detected in time-correlative fine-grained sediments. Based on sedimentary and trace fossil evidence, the late Permian of Guryul has been interpreted as relatively shallow, neritic and delta-influenced. The so-called 'tsunamites'

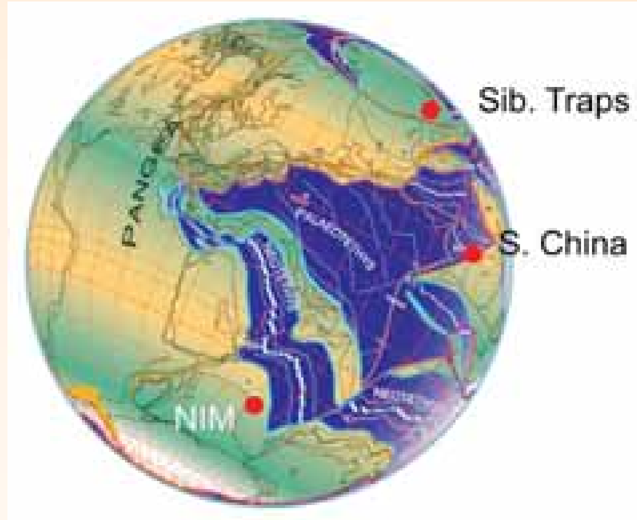

Fig. 49: Equatorial Tethys View.

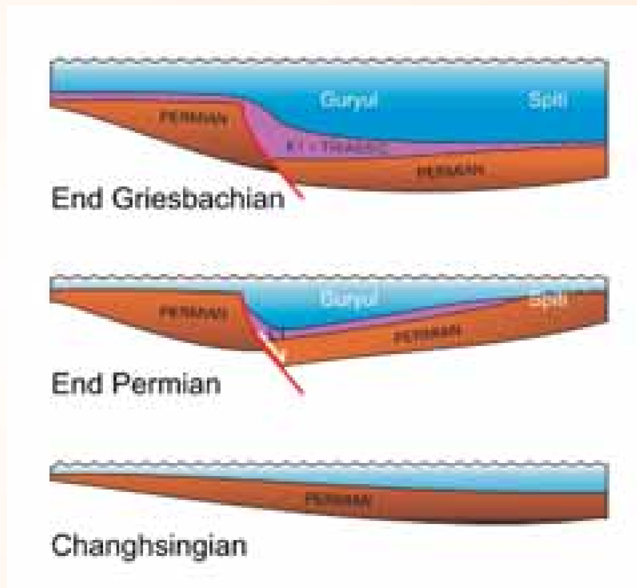

Fig. 50: Synsedimentary tectonic activity with tilting and eventual Horst and Graben structure building to sedimentary breaks during Permian to Triassic.

are shelly-enriched discontinuous carbonate lenses fed down slope through local channels. Judging from the distinct facies change from the storm-related 'tsunamites' to thinly bedded mud turbidites above, a sudden deepening may be explained by local rift-related tectonics along the North-Indian Gondwana Margin (NIM) which led to episodic seismic induced sediment redeposition in the area of Guryul Ravine (Fig. 49). Syn-sedimentary tectonic activity with tilting and eventual Horst and Graben structure building to sedimentary breaks and 20 times thinner, condensed limestone deposits far offshore from

Guryul in Kashmir (Krystyn et al., 2004) and Tibet (Orchard et al., 1994). Thus, local seismic activity seems to be a far more logic explanation of the Guryul 'tsunamites' than the eruption of the Siberian Traps which are more than 6000 km away (Fig. 50).

Indo-Norwegian Collaborative Project

Earthquake Hazard and Risk Reduction on the Indian Subcontinent (RRISC)-Towards an earthquake- safer environment

(Vikram Gupta)

During the year, the major focus was on the slope stabilities in the Nainital township. The township is known to be vulnerable to landslides since past many years, and it has been reported that half of the area of the township is covered with debris generated by landslide. The area has been continuously monitored for the last more than three years, as the distress in the area has been reported in the form of development of cracks. The general geology of the area includes dominantly limestone with shale and slate belonging to the Krol Formation. The rocks in the area are mapped as highly crushed and weathered due to the presence of the Nainital Lake Fault that extends into Balia Nala as Balia Nala Fault.

A disastrous landslide has struck in the Rais Hotel locality on the right side of the Balia Nala during September 2014 after the excessive rainfall. Ground displacement has also been recorded in the army camp in the Kailakhan area, located on the left bank of the Balia Nala. The Ground Penetrating Radar study has also been carried out at number of slopes at different elevations in the township including the right side of the BaliaNala. The objective of the study was to ascertain the thickness of the overburden on the slopes. The study showed that the thickness of the overburden/thin debris cover is of the order of 5-10 m. This has also been confirmed by the borehole data. In addition, engineering geological characterisation and geotechnical studies of the rocks and soils have been done and study confirms that the rocks and soil located in the area have very low strength. Digital elevation model (DEM) of the township has also been prepared using high resolution satellite data and many thematic maps including slope, relief, aspect, drainage density etc have been derived. The preparation of the Landslide hazard zonation map of the area is underway. In order to prevent further sliding, it is proposed that immediate measures has to be taken to channelize water on both sides of the hill slopes so that the ingress of water into the slope is minimum.

DST Project

Centre for Glaciology

(Anil K. Gupta, D.P. Dobhal, Indira Karakoti, Rakesh Bhambri, Amit Kumar, Akshaya Verma, Sameer Tiwari, R.S. Ahluwalia)

During the year, extensive field work for routine glacier monitoring programme to generate high quality time series data on glacier dynamic, snout fluctuation, meteorology, glacial hydrology, sediment transfer, melt-water chemistry, isotopic characterization of glacier melt, precipitation (snow and rain) and glacial geomorphology has been carried out. Data collected during the period were compiled and analysed. In addition, a new research station has been established along with meteorological and hydrological observatories at Dunagiri and Bagni glaciers, Dhauli Ganga basin. Isotopic and melt water chemistry studies for the Gangotri Glacier have also been initiated. Remote Sensing and GIS software lab has also been established within the Centre.

Glacier Mass Balance Response to Meteorological Variables and Surface Characteristics

In order to test the sensitivity of surface energy mass balance (SEMB) model, the model was run using altered the contrasting meteorological variables like, near-surface air temperature (T_a by 1°C), surface temperature (T_s by 1°C), relative humidity (R_H by 20%), precipitation (P by 20%) and surface characteristic debris thickness (h_d by 20 cm) during the ablation period. Based on the perturbation of each variable, sensitivity of model was determined by computing the relative change in specific mass-balance for each variation (Fig. 51). Results indicate that if T_a was increased by 1°C, 0.21 mw.e. more melt water (an increase of 5%) would run off at the K1 AWS site while deficiencyof 0.20 mw.e. (a decrease of 5%) in surface melt would occur if T_a was decreased by 1°C (Fig. 51). Similarly, if T_s was increased by 1°C then 0.21 mw.e. more melt water (an increase of 5%) would run off while 0.20 mw.e. (a decrease of 5%) less ice would melt if T_a was decreased by 1°C (Fig. 51). Changes in the specific mass-balance for perturbations of R_H are -0.06 mw.e. (2%) and 0.05 mw.e. (1%) for +20% and -20% humidity perturbations, respectively. An increase of 20% in P directly influences the amount of accumulation, but simultaneously changes the albedo and consequently reduces the net energy of the system which leads to less surface melting of glacier. The changes in specific mass-balance for perturbations of P are -0.11 mw.e.

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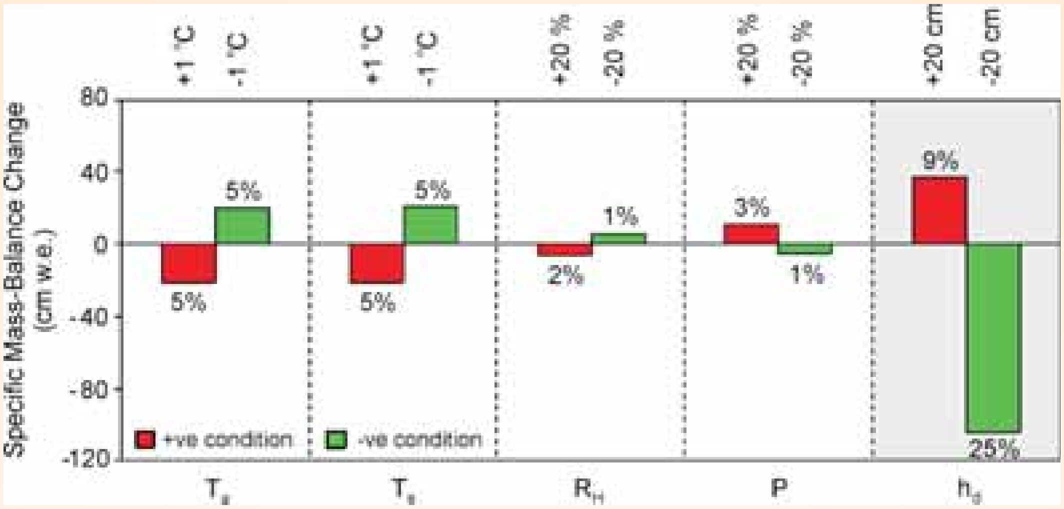

Fig. 51: The sensitivity of specific mass balance (computed from SEMB model) at glacier ablation zone was examined by perturbations of T_a (±1°C), T_s (±1°C), R_H (±20%), P (±20%) and h_d (±20 cm). T_a, T_s, R_H, P and h_d are representing the near-surface air temperature, surface temperature, relative humidity, precipitation (snow and rain) and debris thickness, respectively. Condition coloured with grey is showing the surface condition while rest are showing meteorological conditions.

(3%) for -20% and 0.05 mw.e. (1%) for +20% which indicates that the sensitivity of change in summer precipitation is lower than the other meteorological variables. Overall, the sensitivity of the SEMB model suggests that the specific mass-balance is more sensitive for the perturbation of T_a and T_s than any other variables especially in the ablation area of the glacier during the summer.

Besides, the study of effect of perturbation in meteorological conditions to SEB model, the sensitivity of SEMB model was also analysed using altered surface characteristic by changing the supra-glacial debris thickness (h_d) of 20 cm. Results indicate that if h_d is increased by 20 cm, deficiency of 0.37 mw.e. (a decrease of 9%) in ice melt would occur while 1.04 mw.e. (an increase of 25%) more ice would melt if h_d is reduced by 20 cm (Fig. 51). The results indicate that the SEB model is nearly two times more sensitive to a decrease of h_d by 20 cm.

Hydro-meteorological studies over Dokriani Glacier

Melt water discharge and suspended sediment concentration data were collected at the existing gauging site from Dokriani Glacier during May-October 2014. Velocity area method was used to estimate the mean discharge in the river. Stage vs Discharge relationship for Dokriani Glacier has been developed to calculate discharge for the available water level records of 2014 (Fig. 52).The discharge showed

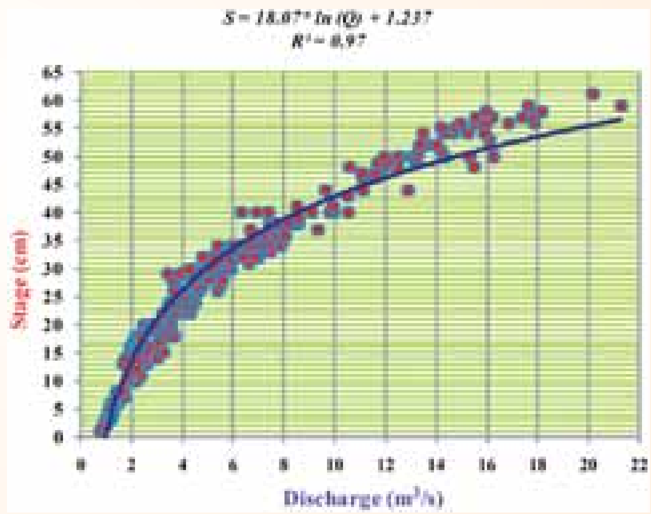

Fig. 52: Rating curve and equation developed for discharge measurement at Dokriani Glacier during ablation season 2014.

increasing trend from May onwards, reached its highest value in August and then started reducing. The distribution of daily discharge and suspended sediment concentration and load are shown in figure 53. The mean monthly discharge observed during study period for different months i.e. May, June, July, August, September and October are respectively 1.1, 3.0, 9.8, 11.8, 4.7 and 2.2 m^3/s.

Suspended sediment concentration in the observed discharge was very high and highly variable over the

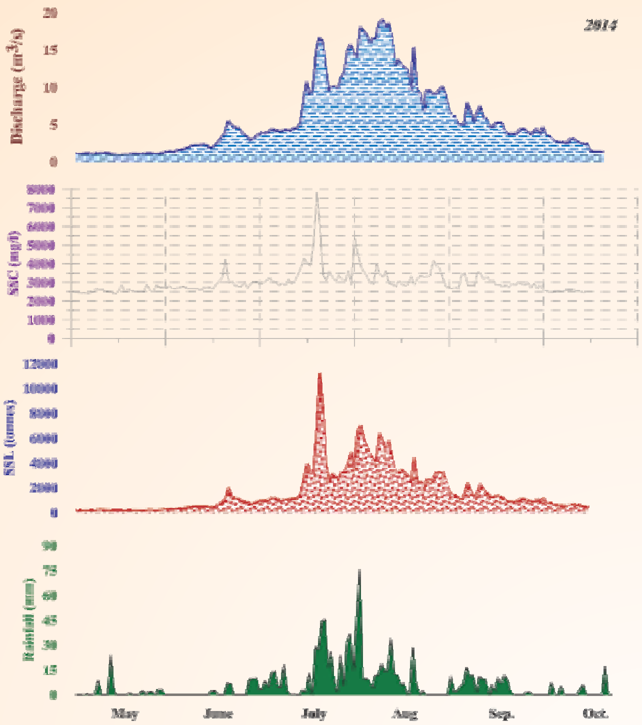

Fig. 53: Daily distribution of hydrometeorological variables over Dokriani Glacier.

melt season. Mean monthly suspended concentration for May, June, July, August, September and October during the year was around 1349, 1553, 2279, 1861, 1625 and 1311 mg/l, respectively. Mean monthly total suspended load for same months during the study period was around 131, 413, 2147, 1935, 673 and 299 tonnes, respectively. The analysis of particle size for suspended sediment is under progress. Daily rainfall was recorded for the year 2014 during different months May, June, July, August, September and October and it is around 50, 63, 517, 226, 135 and 31 mm, respectively. It can be seen from the figure that the maximum amount of rainfall is experienced during the month of July whilst October experienced less rainfall. Total rainfall observed at Dokriani Glacier is ~1021 mm during the melting season (May-October).

Inventory of Glacier Lakes in Uttarakhand

During the year, identification and mapping of the glacier lakes based on high resolution remote sensing images (2011-2013), located in the state of Uttarakhand and classification of these lakes with inventory parameters have been carried out. 1266 glacier lakes (size >500 sq. m) have been identified covering an area of 7.6±0.4 sq. km (as shown below). Of these 1266 lakes, 809 have been classified as ice-dammed lakes (supra-glacial lakes), having a total area of 2.0±0.1 sq. km (26.3% of the total glacier lake area).

The maximum numbers of glacier lakes (809 counts) are grouped under ice-dammed lake (supra-glacial lakes) category, whereas maximum glacier lake area (52%) is occupied by the moraine-dammed lakes (329 count and total area 3.9±0.2 sq. km) (i.e. end moraine, lateral moraine, recessional moraine and other moraine lakes). Altitudinal distribution of these lakes varies from 2900 m to 5850 m. An artificial lake, Auli (1900±97 sq. m) is situated at a minimum elevation of ~2900 m in Alaknanda basin. A supra-glacier lake of Bhagirathi basin shows maximum mean elevation (5850 m). The largest lake classified as end-moraine dammed lake (244742±12482 sq. m) in Uttarakhand is located in Bhilangna basin. The maximum number of glacier lakes is seen in Alaknanda basin (635 counts) whereas, no lake is seen in Ramganga basin. In addition, maximum area of glacier lakes are distributed in Alaknanda basin (3.4±0.2 sq. km).The study has great socio-economic importance as it will apprise stake holders to about their potential threat from outburst flood and thus allow people to settle at the safer places.

Glacier lakes inventory of Uttarakhand

Main type	Sub type	Total number	%	Total area (sq. m)	%	Mean area (sq. m)
Moraine-dammed lake	End moraine-dammed lake	44	3.5	15,96,367	21.0	36,281
	Lateral moraine-dammed lake	67	5.3	6,52,054	8.6	9,732
	Recessional moraine-dammed lake	214	16.9	15,89,375	20.9	7,427
	Other moraine-dammed lake	4	0.3	98,143	1.3	24,536
Ice-dammed lake	Supra-glacial lake	809	63.9	20,00,524	26.3	2,473
Glacier erosion lake	Cirque lake	48	3.8	11,74,222	15.5	24,463
	Other glacial erosion lake	77	6.1	4,66,491	6.1	6,058
Other glacial lake	Other glacial lake	3	0.2	17,695	0.2	5,898
	Total	**1266**		**75,94,871**		

SPONSORED PROJECTS

MoES Sponsored Project

Multi-Parametric Geophysical Observatory for Earthquake Precursory research at Ghuttu, Garhwal Himalaya

(*Naresh Kumar, Gautam Rawat, Devajit Hazarika, P.K.R. Gautam*)

In order to study earthquake precursor in an integrated manner, Multi-Parametric Geophysical Observatory (MPGO) was set up at Ghuttu, Garhwal Himalaya with the continuous data recording by various instruments. A careful scrutiny of the data revealed the recording of anomalous changes with the 2007 Kharsali earthquake (Mw 5.0), the nearest strong event located within ~60 km radius and 22 other events having magnitude >4.0 located within 200 km radius. Similarly, radon fluxes show some definite trend that can be viewed as pre- and co-seismic changes related to Kharsali earthquake and similar size earthquakes. Sudden drop of geomagnetic field intensity and dynamic waveform, lasting from several days before to a week after the earthquake, appears to be a manifestation of the thermal agitation on the magnetization of rocks around the source region of the earthquake. The results obtained so far for few moderate magnitude earthquakes (4.0>M>5.0) occurred within 200 km have some promises to earthquake precursors in multi-parameter approach. During previous year, two earthquake events of M4.1 and M4.5 were recorded from epicentre distance of 145 m and 154 m, respectively. These events are not able to induce effective anomalous changes in the continuous time series of MPGO because the large epicentre distance and low magnitude. On the basis of epicentre distance and magnitude, a statistical parameter has been adopted which give the radius of effective strain for inducing anomalous changes. The continuous measurement of gravity data through superconducting gravimeter also show co-seismic changes observed during the time of occurrence of some moderate magnitude earthquakes.

Electromagnetic field variation

In order to study the preparation process of an earthquake using geomagnetic field or electromagnetic field variations, the biggest issue is identifying seismo-electromagnetic signals in the background of signals from solar-ionosphere contribution. For this purpose, (i) simultaneous observation at more than one site is performed, (ii) due to comparatively lesser contribution of ionospheric contribution during night time, night time data of geomagnetic field variations are used. Polarisation ratio is another parameter which is used for identifying SEM signals. Another approach is considering earthquake preparation process having flicker noise characteristic and observing temporal evolution of fractal dimension. There was an earthquake of magnitude 4.0 near Uttarakashi in the morning hour, details of which are given below:

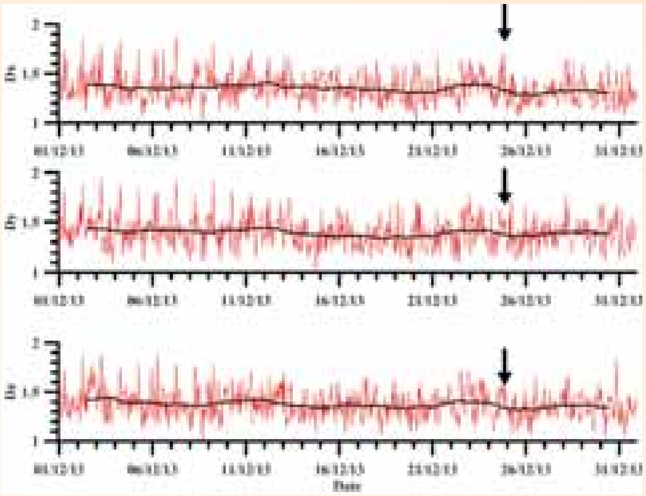

Fig. 54: Temporal evolution of Fractal dimension for December 2013.

The fractal dimension of hourly time series obtained after averaging 1 sec DFM data has been calculated. Higuchi method has been used for estimation of fractal dimension. Figure 54 is the plot representing temporal evolution of fractal dimension for the month of Dec 2013. Solid black lines are running average of three days values. The daily fluctuation of fractal dimension can be related to diurnal variation of Sun-Earth interaction whereas, long period variations obtained after running average may be related with earthquake preparation processes. Rise in fractal dimension before the earthquake indicates the increasing complexity in seismogenic processes. This observation of increasing fractal dimension is consistent with previous observations of variability of fractal dimension of ULF band magnetic field variations before the earthquake.

Date of Earthquake	Magnitude	Time (UTC)	Latitude	Longitude	Depth	Distance from Ghuttu
25.12.2013	4.0	02:56:52	31.2	78.3	10	86

Peak Ground Acceleration

During January 2013 to January 2015, 15 local earthquakes have been recorded by accelerograph station. The hypocentral parameters of these earthquakes are presented in table below. The Peak Ground Acceleration (PGA) value has been computed for these earthquakes and found to vary from 0.40-3.34 mg. These have been plotted as a bar diagram with respect to magnitude and epicentral distance in figure 55. Near the event from the recording station and more is the magnitude, the PGA will be more. The data of different geophysical parameter is also assessed to check anomalous behaviour for these events and it is expected that higher PGA should indulge high variation.

GPS Studies

GPS data for five years (2007-2011) of GHUT station, MPGO Ghuttu through GAMIT/GLOBK software in ITRF05 reference frame on 95% confidence level have been analysed and daily time series plots for each year were generated. IGS station LHAS was also included in the processing. The comparative analysis indicates convergence between GHUT and LHAZ with the rate of convergence ~15 mm/yr and ~23 mm/yr, respectively. Anomalous changes in the time series of GHUT before, after and during the occurrence of local earthquakes for both cases when the earthquake lies within or out of strain radius have also been examined. For this purpose seven local earthquakes of magnitude ranging between 4.5 and 5.7 were considered on the basis of strain radius equation. Significant parameters that play an important role to change the behaviour of GPS time series have been inferred.

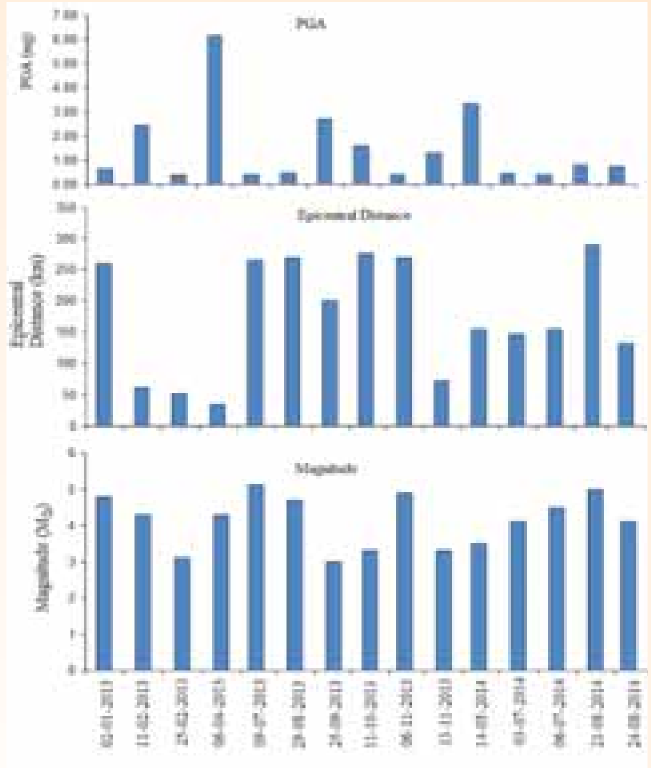

Fig. 55: The bar diagrams show PGA values of the recorded earthquakes with respect to magnitude and epicentral distance of the corresponding earthquakes.

Local earthquakes recorded by accelerograph at MPGO, Ghuttu

Date	OT	Latitude	Longitude	Region	Distance	Depth	Magnitude	PGA(mg)
02-01-2013	17:42:15	29.40	81.80	Nepal	259.74	10	4.8	0.63
11-02-2013	10:48:55	31.00	78.40	Uttarkashi, UK	61.54	5	4.3	2.44
25-02-2013	02:28:25	30.90	78.40	Uttarkashi, UK	52.38	11	3.1	0.36
06-04-2013	22:29:31	30.50	79.10	Rudraprayag,	34.65	10	4.3	6.02
09-07-2013	13:49:13	32.90	78.40	J&K-HP Border	265.49	10	5.1	0.39
29-08-2013	10:13:21	31.40	76.10	Kishtwar, J&K	269.66	10	4.7	0.48
25-09-2013	16:47:40	30.90	76.70	Rupnagar, Punjab	199.62	10	3	2.69
11-10-2013	18:05:34	28.80	76.70	Rupnagar, Punjab	275.19	10	3.3	1.61
06-11-2013	14:53:08	31.40	76.10	Hoshiarpur, Punjab	270.00	10	4.9	0.40
13-11-2013	23:33:41	30.00	79.20	Garhwal, UK	73.50	5	3.3	1.29
14-05-2014	01:54:01	29.80	80.10	Pithoragarh, UK	153.94	7	3.5	3.34
03-07-2014	11:34:59	30.20	80.20	Pithoragarh, UK	145.02	10	4.1	0.43
06-07-2014	14:48:09	30.20	80.30	Pithoragarh, UK	154.34	10	4.5	0.42
21-08-2014	08:11:17	32.30	76.50	Kangra, HP	289.57	10	5	0.80
24-08-2014	08:29:31	29.90	79.90	Bageshwar, UK	131.70	5	4.1	0.73

Young Scientist Project

Hydro-climatic Response and Isotopic Characterization of Glacier Melt-runoff from Dunagiri Glacier, Dhauli Ganga Basin, Garhwal Himalaya

(Amit Kumar)

Meteorological Observations and Analysis

During the year, a conventional meteorological observatory was established about 2 km downstream of the snout of the Dunagiri Glaciers for recording parameters like temperature, relative humidity, rainfall and wind velocity. The thermometers were kept inside a Stevenson's screen, at a height of 2 m. Daily precipitation recorded for year 2014 during different months June, July, August and September was 13.1, 76.4, 49.0 and 41.2 mm, respectively. The total annual rainfall was observed to be 180 mm. It has been observed that maximum amount of rainfall is experienced in the valley during the month of July, whilst June experienced minimum rainfall. Distribution of daily rainfall for the year is shown in figure 56.

The mean monthly maximum and minimum air temperature for different months i.e. June, July, August and September was observed to be 17.6, 15.1, 14.9 and 14.1 and 4.3, 6.4, 6.4 and 5.0°C, respectively, whereas, mean monthly temperature was observed to be 10.9, 10.8, 10.6 and 9.5°C, respectively. The diurnal temperature range is higher in the beginning of the melt season but it reduces as the melt season progresses. Daily variation in mean temperature has been plotted in figure 56. The daily values of relative humidity ranged between 65 and 98%.

The daily mean wind speeds for June to September were 3.2, 1.4, 1.0 and 1.7 km/h, respectively and the average wind speed for the whole season was found to be 1.7 km/h. Observation on sunshine was made round the clock using automated instruments. Mean monthly values of sunshine hours for different months during the 2014 melt period in June, July, August and September

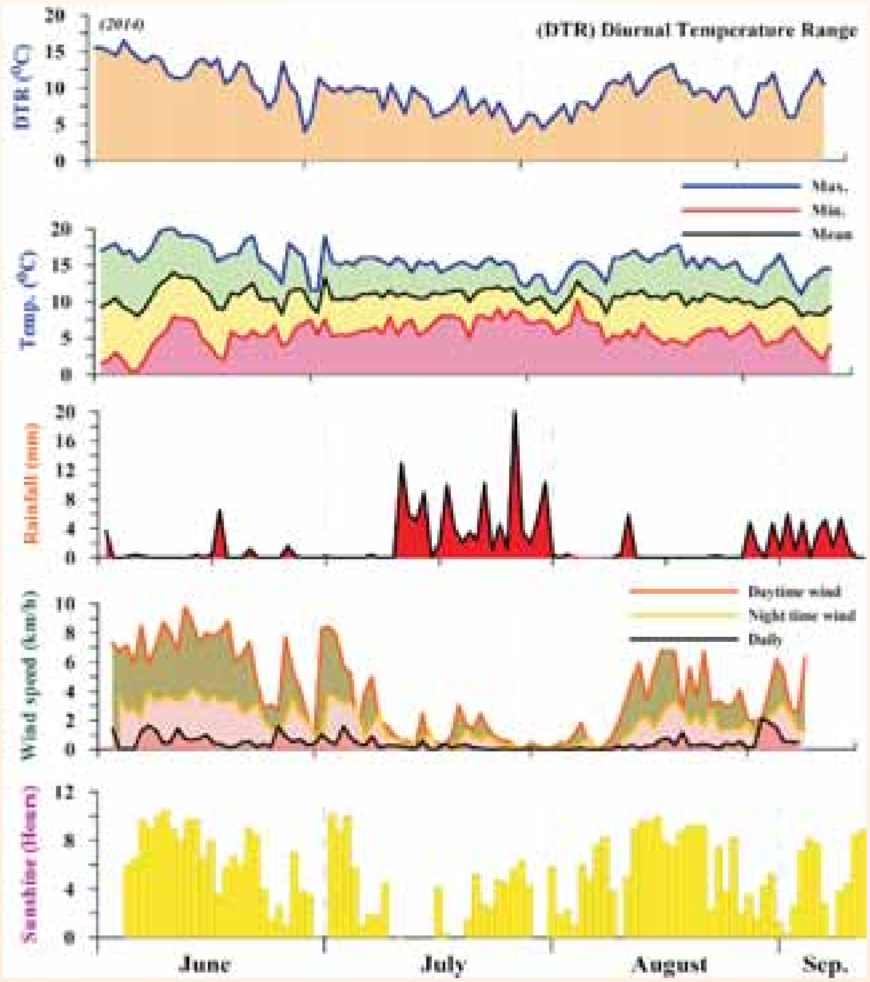

Fig. 56: Distribution of meteorological data collected near the snout of Dunagiri glacier.

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were 7.4, 2.8, 5.7 and 4.4 hrs, respectively. Maximum bright sunshine hours observed in the month of June, July, August and September are 10.50, 10.17, 10.0 and 8.8 hrs, respectively. The maximum mean monthly bright sunshine hours are observed in the month of June followed by September.

Hydrological Observations and Analysis

A gauge and discharge site has been established at river near the snout of Dunagiri glacier. In order to measure the water level data, an automatic water level recorder was installed on the artificial well near the bank of the river. A graduated staff gauge was also installed for the manual observations of water level. Calibration was made between water levels observed at the staff gauge and water levels in the well. Manual observations of water levels were made during day and night time. This manual data set was used to cross-check of recorded level fluctuations in the river. The surface velocity of stream flow was also measured and observed to be in the range of 1.4 to 2.9 m/s. For the measurement of water velocity, the channel was divided into four segments. The cross-section area of the channel was determined with the help of sounding rods in the beginning of the season and was rechecked at the end of the season before closing the investigations. For measurement of discharge, velocity area method was used to estimate the flow in the river.

Rating Curve for Dunagiri Glacier Meltwater stream

A stage-discharge relationship for the gauging site was developed after analysing the observed gauge and corresponding discharge data (Fig. 57). This relationship was used to compute the hourly discharge values corresponding to the hourly gauge values for which no discharge observation were made. Such relationships were developed for each summer season separately and were used to convert water levels into discharges. The mean monthly discharge observed during study period for different months such that i.e. June, July, August and September are respectively 2.0, 3.5, 4.2 and 3.7 m^3/sec, whereas, the mean monthly discharge was observed to be 3.4 m^3/sec.

The suspended sediment concentration in the observed discharge was high and highly variable over

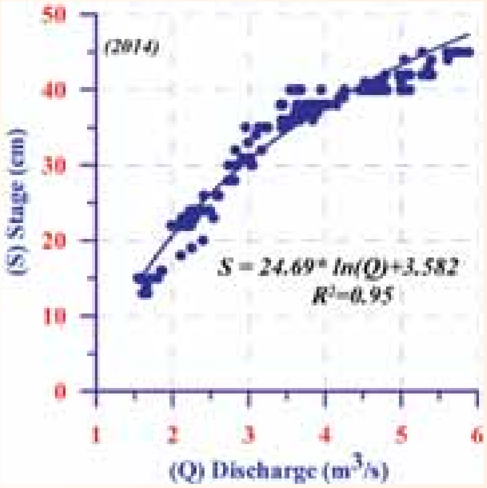

Fig. 57: Rating curve for Dunagiri Glacier melt-water stream for the years 2014.

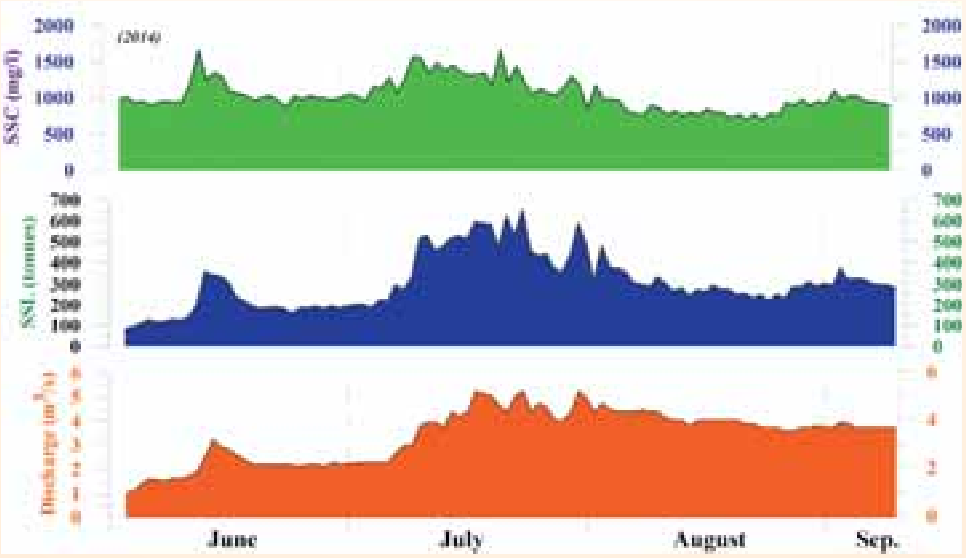

Fig. 58: Distribution of daily discharge, suspended sediment concentration and load near the snout of Dunagiri Glacier.

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the melt season. Mean monthly suspended concentration for June, July, August and September during the study period was 1062.6, 1224.7, 888.5 and 958.5 mg/l, respectively (Fig. 58). Whereas, the mean monthly total suspended loads for same months during the study period were 191.2, 380.5, 325.1 and 309.9 tonnes, respectively (Fig. 58). The analysis of particle size for suspended sediment is under progress. The samples of rainfall, snow, ice and discharge at discharge measuring site were collected for isotopic analysis of each component (rain and snow).

MoES Project

Quaternary Landform Evolution along the Himalayan Frontal Thrust of India: Insight to the patterns of strain release along a Continental Convergent Plate Boundary

(R. Jayangondaperumal and Pradeep Srivastava)

To understand the paleoearthquake history and recurrence interval of Himalayan earthquake and to quantify the long-term uplift rate two months of field work in the northeast Himalaya was carried out. In the lab, several fault scarps were identified using high resolution imagery. During field work all scarps that were marked in the lab were thoroughly examined. Four potential trench sites were identified at Roing, Pasighat (Fig. 59), Niglok and Hemi Basti in Arunachal Himalaya. These sites were surveyed before placing a trench using RTK GPS to obtain micro-topographic map. Trench was placed at respective sites (Fig. 60). Trench exposure was cleaned to study the statigraphic relation with structures identified in the trenched fault zone. Logging of trench exposure was made using 1 m x 1 m grid. Simultaneously, every one meter gridded exposure was captured for making photo mosaic. About 60 charcoal samples were collected from four trench exposure for constraining timing of earthquake event. In addition, about 35 OSL samples were collected to constrain the depositional and vertical deformation history at longer time scale.

Fig. 60: Trench across the 3 m high scarp. View from the hanging wall.

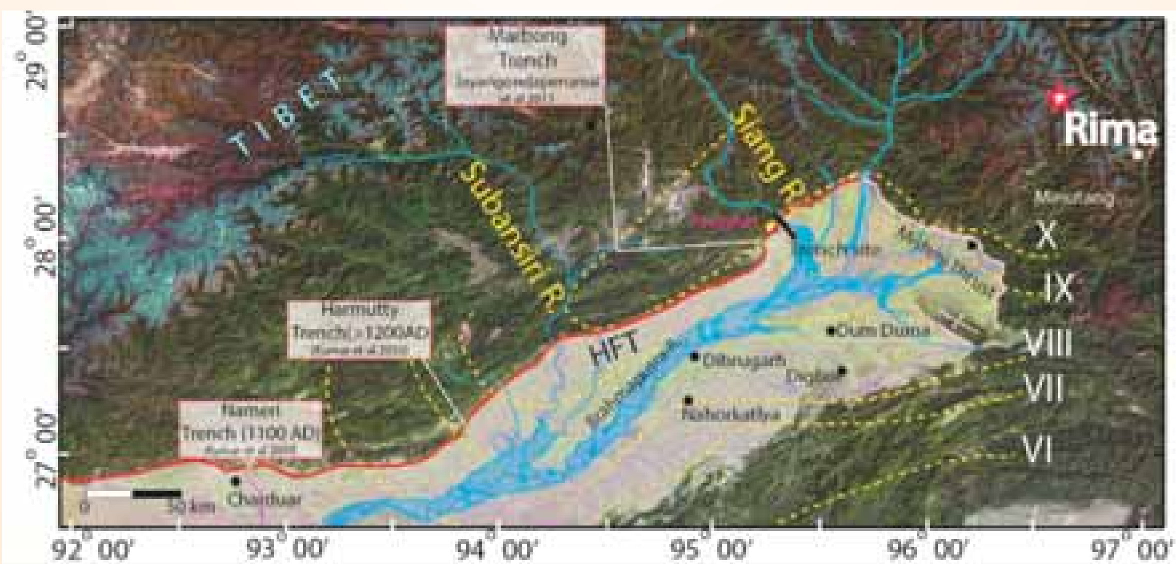

Fig. 59: SRTM draped with Landsat Image showing isoseismal of the A.D. 1950 Assam earthquake (adopted from Poddar 1950) along with location of trench site studied under this project. The site is located in the Pasighat town near PWD guest house, Arunachal Pradesh. Previous trench locations are also shown by solid square connecting with rectangle box with site location name.

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MoES Project

Neo-active tectonics of Surin Mastgarh anticline and associated structures around Ravi River exit area in the Panjab Sub Himalaya: Implication for Seismotectonics of the Kashmir seismic gap region

(R. Jayangondaperumal, V.C. Thakur, and N. Suresh)

2005 Kashmir earthquake of magnitude Mw 7.6 produced 75 km surface rupture showing 3-7 m vertical offset. The surface rupture nearly coinciding with the bedrock geology defined Balakot Bagh Fault (BBF) indicates reactivation of the fault. The BBF extends SE with right-step to the Reasi Thrust in Jammu region. Further SE extension of the Reasi Thrust has been mapped with different nomenclature to the 1905 Kangra earthquake meizoseismal region, suggesting linkage between the earthquake and the active fault. There is no historical record of a large magnitude Mw >7 event for the last ~1000 years in the eastern segment of the Kashmir seismic gap may imply ~12 m slip deficit in the region.

DST Project

Damage Assessment Mapping of Bhagirathi Valley with special reference to extreme rainfall event of the June 2013, Uttarakhand

(A.K. Gupta, Pradeep Srivastava (Co-ordinator), Vikram Gupta, R. Jayangondaperumal, Manish Mehta and Rakesh Bhambari)

Our field survey in the MANU-Bhagirathi valley implied that there are two zones in Himalaya that most vulnerable during abnormal climatic events such as June 2013 Garhwal extreme events. The Zone-I lies above the Main Central Thrust (MCT) where the rocks are thrusted and tectonically deformed and hill slopes are steeper and where the mountains receive highest rainfall. Such geologic and physiographic conditions make this region most reactive to heavy rainfall events. For example, this survey has shown that the area above Uttarkashi had most number of landslides and where the bridges and culverts were also damaged. The Zone-II lies in the lower reaches where the hill slopes are rather gentler and rains are lesser intense but the higher population density and anthropogenic interference combined with week rocks like phyllites made the few zones that failed during the event and therefore the survey witnessed another cluster of damaged roads and high density of landslides in the Lesser Himalaya.

DST Project

Damage Assessment Mapping of Yamunotri Valley with special reference to extreme rainfall event of the June 2013, Uttarakhand

(A.K. Gupta, Vikram Gupta (Co-ordinator), P.S. Negi, Gautam Rawat and B. Venkateshwarlu)

Stretch of the Yamuna valley between Yamunotri temple and the Vikasnagar township, covering a span of about 150 km along road has been studied in this project. All the data collected related to damage caused by the 2013 extreme rainfall event were collected and analysed. More than 2500 points were surveyed and it has been inferred that,

- during the last 4-5 years, the trend of intensity of rainfall in the area, in general, has increased, and at many places in the valley, the frequency of occurrences of cloudburst has also increased. This has resulted in the increased occurrences of landslides/slope instability. It is therefore necessary to carry out large scale landslide hazard zonation mapping of the area
- during the extreme rainfall event of June 2103, water level in the Yamuna river at the Yamunotri temple site had risen to about 2 m which is lower than the level of water that had risen during the preceding years. However the kinematic analysis of the slope indicates that Yamunotri temple is located at very high vulnerable zone. The probable hazard is from the rock fall from the slope and the flood during the high discharge. It is therefore suggested to stabilise the slope located behind the temple using rock anchors/rock bolts, and wire-meshing. Flood protection measures is also to be provided to the base of the temple, and also by constructing flood protection wall from the temple base upto 150 m upstream of the temple
- the footpath leading to the Yamunotri temple from the Janki Chatti is a narrow bridled path, and at places is vulnerable to rock fall and landslide. It should be stabilized using wire-mesh and rock anchoring, wherever possible.
- four hot-spots have been identified in the area. These hot-spots should be studied in detail so as to stabilize the slopes. One such spot is located near village Wariya, (30º55´36.00″N and 78º23'35.80″E), about 35 km west of Tehsil Headquarter Barkot between Rana Chatti and Hanuman Chatti.
- since damages have occurred downstream of the hydropower projects, (Two hydropowers are located

in the Yamuna valley, one near village Kharadi and another in the tributary of Yamuna river, near Hanuman Chatti) because of the sudden release of water from the project site. It is therefore suggested to formulate a policy of release of water from the dam, in case of any unforeseen conditions, like flooding of during June 2013.

- It has been observed that damages to the buildings and other infrastructures in the area had occurred whenever these were located on the river flood plains or on the river terraces.

MoES Project

On establishment of two new permanent GPS stations in Panamik at J&K and Pithoragarh region in Uttarakhand

(P.K.R. Gautam and Rajesh S.)

To enlarge the existing network of GPS stations and understanding the present day convergence rate of the various crustal blocks in the Himalaya, two permanent GPS station one at Pithoragarh in Uttarakhand and another one at Tangtse in J&K have been installed. These stations at have been functional since July 2012 and September 2012, respectively, and the analysis of data of both stations have been carried out till December 2013. The pre-processing is done by TEQC utility software, and the post processing has been performed through the latest version of GAMIT/GLOBK software package in ITRF08 reference frame. In addition to these two stations, data from IGS stations, namely, BAN2, HYDE, IISC, LHAZ, KUNM, KIT3, POL2, SELE, TEHN and LCK2 have also been utilised. The results in terms of time series and velocity vectors with respect to Eurasian plate and Indian Plate have been obtained (Fig. 61).

DST Project

Geodynamic evolution of the mylonitic zone across the Lesser Himalayan Belt of the Eastern Himalayan Syntaxis in Arunachal Himalaya, Northeast India

(R.K. Bikramaditya Singh)

Geological fieldwork has been carried out in November-December 2014 in Siang, Lohit and Dibang valleys of Arunachal Pradesh. The Lesser Himalayan Crystallines consist of quartzite, gneiss, phyllite and schist. This unit is limited at the base by the Main Boundary Thrust (MBT) and overlain by the Higher Himalayan Crystallines along the Main Central Thrust (MCT). The Lesser Himalayan Granitoids (LHG) are exposed as a narrow belt in the eastern limb of the Eastern Himalayan Syntaxis i.e., in the Lohit and Dibang valleys. The LHG are medium to coarse-grained, light to dark grey coloured rocks. They exhibit foliation which is well defined by the alignment of muscovite and biotite. The LHG exposed in the Dibang and Lohit valleys have similar mineral assemblage. Detail petrography of the rocks have been carried out. The deformation microstructural features of K-feldspar, plagioclase and quartz indicate that the LHG have undergone ductile deformation superimposed by brittle deformation. The k-feldspar in the LHG is mostly orthoclase. The plagioclases are sodium-rich and range from albite to oligoclase. Plagioclase zoning is not observed that the analyzed plagioclase shows uniform composition from core to rim.

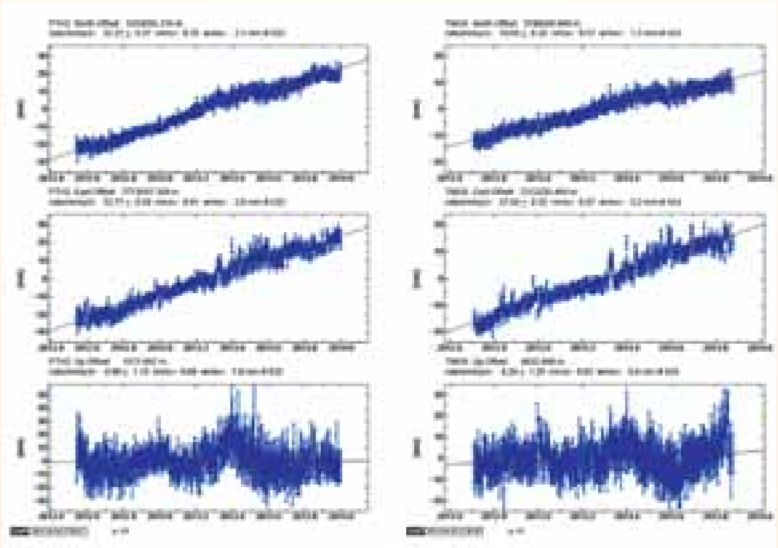

Fig. 61: Time series of PTH2 and TNGS GPS stations

The chemical composition of biotite in the LHG is characterized by high Al contents 2.56-3.18 a.p.f.u with variable Mg values of 0.76-2.23 a.p.f.u. The FeO^t/MgO ratio of biotite in LHG ranges from 3.21 to 5.11 (average of 1.59) and siderophyllite in composition which are typically close to peraluminous (S-type) suite. The whole rock chemistry of the LHG samples shows high content of SiO_2 (63-77 wt.%) and Al_2O_3 (12-17 wt.%) with low abundance in Fe_2O_3, MgO, MnO and CaO. A wide variation of trace elements has been observed, particularly in Ba (113-1509 ppm), Rb (72-513 ppm), Sr (<323 ppm), Th (8-149) and Zr (61-404 ppm) with less variation in U (<16 ppm), Y (12-72 ppm) and Nb (4-72 ppm). Concentrations of trace elements in LHG are similar in both the Lohit and Dibang valleys. Overall, the samples are enriched in the large ion lithophile elements (K, Ba, Rb) and depleted in high field strength elements (Nb, Y). Variation diagrams of major and selected trace elements of the samples exhibit negative trends in TiO_2, Al_2O_3, Fe_2O_3, MgO, CaO, MnO, P_2O_5, Sr, Ba and Zr against SiO_2. Most of the LHG samples have geochemical characteristic of granite. The high molar $Al_2O_3/CaO+Na_2O+K_2O$ (A/CNK) ratio values range from 1.0 to 1.7 with normative corundum values (0.4-6.4) suggesting a peraluminous nature. The REEs abundance ranges from 60 to 565 ppm, and have similar normalized REE patterns of granite.

DST-Fast Track Young Scientist Scheme Project

Reconstructing palaeoclimate and landscape history in Lahaul and Spiti, Himalaya using cosmogenic radionuclides (^{10}Be and ^{26}Al)

(Archna Bohra)

The main objective of the project is to establish a glacial chronology using ^{10}Be and ^{26}Al. For this a detailed fieldwork was carried out in Lahaul and Spiti region. The altitude within the research area ranges between 3300 and 4300 m asl. The study area contains good example of glacial and paraglacial features. Three sites were chosen within Spiti valley namely, i) Sonapani ii) Chataru, and iii). Losar. Samples were collected from boulders on moraines, drumlins and glacially polished bedrocks surface to generate the baseline dataset from study area, and some OSL sample were also collected for comparative study. Approximately 500 gm of samples were collected from top 2-3 cm of the moraine/glacially varnished bedrock surface using hammer and chisel for ^{10}Be dating. Topographic shielding was measured using a hand clinometer at 15 degree azimuth intervals. Sample were broken into chips, then crushed in jaw crusher and sieved to make 250 to 500 µm size fraction. These different grain size fractions were washed and dried repeatedly prior to magnetic separation. Chemical processing of the samples is under process.

DST Women Scientist Project

Palaeobiology of the Birmania Basin, Rajasthan and its correlation with the Krol-Tal belt of Lesser Himalaya

(Rajita Shukla)

Birmania Basin, an oval-shaped, isolated remnant of the Marwar Basin is located in the centre of the Thar Desert of western Rajasthan. The published isotopic data indicates an Ediacaran-Early Cambrian age for this basin. Field work was carried out in the area during February, 2015. Lithologs of the identified sections were prepared and systematic sampling was carried out in these sections. Birmania Basin is divided into two formations: the lower Randha Formation and the upper Birmania Formation. Randha Formation mainly comprises of siliciclastic rocks. The exposures occur as numerous hillocks, around Randha village. The older gritty facies comprises of poorly sorted, medium-grained rocks which grade into younger sandy and shaly facies. Birmania Formation overlies the Randha Formation and is exposed around villages Birmania and Barsinga. The rocks around Barsinga village are calcareous, grey coloured, showing elephant skin weathering. They appear to be dolomitized as seen in some petrographical, thin sections. Light to dark grey, resinous bands, lenses and large nodules of chert occur deeply embedded within the calcareous rocks. The bands are ~ 1 to 3 cm thick, very hard and resistant to weathering. The rock types around Birmania village are mainly calcareous with siliceous content. Numerous pits have been dug in this area by the Rajasthan State Mineral Development Corporation from where samples were collected. Dark, bands of phosphorite were present along with calcareous sandstone and shale. The area shows multiple folding and deformation of bedding.

The depositional pattern of Birmania Basin shows some similarity with the Krol-Tal belt where the siliciclastics (Randha village-Infrakrol Formation) are overlain by carbonate dominant lithology (Barsinga village-Krol Group). This in turn is overlain by phophoritic beds (Birmania village - Lower Tal). As in Krol 'A' Formation, chert in Birmania Formation also occurs in a confined zone within the carbonate layers.

Thin sections of chert, carbonates and siltstones, collected from Randha and Birmania formations, are

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being prepared to be studied under the microscope. The chert samples from the latest field sampling have revealed a very well preserved assemblage of filamentous forms. These forms mainly belong to Genus *Siphonophycus*. The biota discovered so far appears primitive as compared to that of Ediacaran Period. Petrographic study of cherts, carbonates, phosphorites and siliciclastics from the Randha and Birmania formations is also being attempted for definite identification of the rocks and understanding the depositional environment.

Indo-ISOR, Iceland-NGI, Norway collaborative Project

Commissioning of Pilot project for the use of geothermal energy

(S.K. Bartarya, Vijay Chauhan, Guatam Rawat and S.K Rai)

A pilot project for the demonstration of utilization of geothermal energy for space heating was successfully commissioned at Chumathang, Leh, Ladakh in collaborations with ISOR, Iceland, NGI, Norway and DST, Govt of India.

In the Northwest Himalaya the most promising area for the development of geothermal resources of the hot springs and high heat flow provinces are present in the states of J&K, Himachal Pradesh and Uttarakhand. To demonstrate the scientific exploration of such sources, Wadia Institute of Himalayan Geology has initiated a collaborative research project in the Northwest Himalaya with Norwegian Geotechnical Institute, Norway and Geological Survey of Iceland, Iceland, coordinated by DST, Govt of India. Under this project WIHG with collaborating institutions recently installed the facilities to harness the geothermal energy for heating of 3 rooms and a restaurant in a hotel "Lamjing" at Chumathang village in Ladakh area (Fig. 62). This is the first kind of scientific demonstration to harness the geothermal energy in the Himalaya. Usage of solar energy as source of electric power requirement for heating the facilities makes this project unique since it is totally renewable energy project independent of grid power. The project is also a showcase as the world

Fig. 62: Demonstration site of the project for use of Geothermal energy (a&b) Lamjing Restaurant and nearby hot spring (c) heat exchanger and pump for temperature control and lifting of hot water to the restaurant (d) radiators in the room for heating.

highest altitude (4150 above msl) space heating application of geothermal energy for public usage. The installation work involved completion of heat load requirement for three rooms and a restaurant for -20°C ambient temperature. The heating system was designed for 29 kW heat load as per calculation made with building heat load estimation. The high heat load is reflected by the typical structure of houses in Ladakh, due to lack of natural resources available for house construction.

The project shows the scope of such application in India where geothermal potential exists and space heating is a requirement for the people living in extreme cold climate.

DST Project
National Geotechnical Facility (NGF)

(Anil K. Gupta, Vikram Gupta, B. Venkateshwarlu, Ruchika Tandon)

The NGF is a mega-project funded by the Department of Science and Technology (DST), Govt of India and has been established at 11C Circular Road, Dalanwala, Dehradun. It provides the research and consultancy services in the field of Engineering geology, Landslides, Rock and soil mechanics and numerical modelling. Presently, it has been working under the administrative support of Wadia Institute of Himalayan Geology (WIHG), India with technical support of a world class geotechnical institute: Norwegian Geotechnical Institute (NGI), Oslo Norway.

Field work has been carried out in the Hill by pass road (Mansa Devi Hills), Haridwar and the Rahis hotel locality, Nainital to study the landslide activities as well as to assess the behavior of slope material. It has been found that both the areas are susceptible to landslide. Further, the GPR testing had been done in several sites at Nainital to decipher the depth of the overburden at the Top of the rope way point, Nainital playground which is adjoining to the main lake, Balianala landslide area and PPJF-Nainitial. It has been noticed that the thickness of overburden in the area ranges between 5 and 10 m in different sections. The soil collected from the Rais hotel locality exhibits that the friction angle and cohesion are 31° and 1.95 kPa respectively. It is classified as non-plastic sandy silt. In Mansa Devi Hills, several unstable areas where the possibilities of landslides either in form of rock fall or debris fall have been identified. The adverse oint conditions and lower strength of rock/soil may be the cause of slope instability. Presently, the various engineering testings of rock/soil collected from both the sites have been completed. In addition, B. Venkateswarluwas of NGF is also carrying out consultancy work on Geological and Geophysical investigations on Himank Road Darbuk-Shyok-DBO and Sasoma-Saserla, and submitted its report to BRO, Project Himank, Laddak-Leh.

DST Project
Fluid Flow in Ladakh Accretionary Prism, Indus Suture Zone: Implication for Modelling of Fluid Process of Subduction regime

(H.K. Sachan)

The Zildat ophiolitic mélange in the Indus-suture zone, India, records faulting and fluid flow patterns. To characterize the origin and behaviour of syn-tectonic fluids, investigations have been carried out on the fluid inclusions, carbon, oxygen, strontium and lead isotopic compositions, and rare earth element (REE) patterns of syn-tectonic calcite within veins along fault zones in the mélange. The occurrence of CH_4, CO_2 and H_2O-NaCl inclusions are noticed in the quartz-calcite veins. The fluids were entrapped in a range temperature (280-450°C) and pressure (1.6-4.2 kbar) conditions. Their high density character is very well corroborated with the inclusions observed in the nearby Nidar ultramafics rocks; hence these fluids may be sourced from mantle rocks. However, the re-equilibrated morphology of inclusions indicates that the area was highly tectonically disturbed. The studied results reveal local fluid flow that was driven by deformation. The scale of flow that is hinted is quite limited.

The $\delta^{13}C$ values of veins range from -2 to 2‰ VPDB and $\delta^{18}O$ values are in the range of 14 to 22‰ VSMOW suggesting a mixed carbon source (i.e., marine carbonate and organic matter). The vein-forming fluids have positive oxygen isotopic compositions (+2 to +9‰ SMOW) and high $^{87}Sr/^{86}Sr$ values (0.7037 to 0.7057), suggesting that the source fluid was from mantle rocks. The calculated $\delta^{18}O$ (H_2O) values are compatible with mantle as well as ophio-carbonate field/altered oceanic crust field. The high LREE/MREE along with high LREE/HREE and +ve Eu anomaly are suggesting a reducing environment of the fluid source, which can be linked to the mantle or mantle related rocks (such as ophiolites).

The study thus implies that, the veins formed in the response of local fluid flow from nearby mantle rocks (Nidar ophiolites and ultramafics in Zildat ophiolitic melange) present bordering with Indian plate boundary in subduction zone complex of Indus-suture zone.

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Bartarya, S.K. 2014: Geological Feasibility report for the car parking near Picture Palace, Mussoorie. Submitted to Mussoorie-Dehradun Development Authority (MDDA), Dehradun, 11p.

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SEMINAR/SYMPOSIA/WORKSHOP ORGANISED

High Resolution Climatic archives from the lake sequences of Ganga Plain (April 3-4, 2014)

The Wadia Institute of Himalayan Geology in association with Ministry of Earth Sciences, New Delhi conducted a workshop on *'High Resolution Climatic archives from the lake sequences of Ganga Plain'* on April 3-4, 2014. Prof. Anil K Gupta, Director, WIH Ginaugurated and made the opening remarks on the subject of the workshop. The workshop was attended by 30 scientists and senior research students from eight different organizations like, BSIP, PRL, NPL, LU, DU, JNU, IIT-Kgp, and WIHG. The brainstorming session discussed the present status and future scope on the paleoclimatic archives located in Ganga plain, with experts covering major specializations like geomorphology, clay mineralogy, isotope geology, geochemistry and geochronology. The deliberations were focused on several multi-disciplinary themes like:

- Lakes as archives of paleoclimate and their sensitivity to climate change
- Various biological and a-biological proxies of climate change and advances therein
- Chronological methods like Optically Stimulated Luminescence, AMS ^{14}C dating their strengths and weaknesses
- Lake records as sink of cultural changes through time.

In the concluded session, as part of future strategy a project *"High resolution multi-proxy climatic records from lakes of Ganga plain: implication to cultural evolution"* was formulated to focus on (i) High resolution climate record over the period of 5 ka (ii) Erosion and weathering pattern in Ganga Plain vis-à-vis climate change (iii) Carbon suites in the lake sequences, and (iv) Domestication of food grains and spread of agricultural practices across Indo-Ganga-Brahmaputra with time.

Indo-Norwegian Joint Working Group (December 8-9, 2014)

A meeting of the Indo-Norwegian joint committee on Science & Technology was held during December 8-9, 2014 at WIHG, Dehra Dun. The seven members of the Norwegian delegation who attended this meeting included leader and co-chair of the joint working group Mrs. Kari Balke Øiseth, Ministry of Education and Research, Norway and other members from Ministry of Education and Research, Norwegian Centre for International Cooperation in Education, Research Council of Norway and Royal Norwegian Embassy, New Delhi. The Indian delegation consisted of Co-Chair Dr. Arabinda Mitra, Advisor & Head (IBC) DST, New Delhi, Dr. P.P. Khanna, Officiating Director, WIHG, Dr. M.O. Garg, Director, IIP Dehradun, Scientists from WIHG, IBC Division-DST, CSIR, New Delhi and GITA, New Delhi. The meet was coordinated by Dr Rajesh Sharma, Scientist 'G'.

The Indo-Norwegian Joint Working Group discussed current R & D policies and priorities in India and Norway, reviewed the current Indo-Norwegian research activities and explored future scope and activities for joint research through research call. The members of the delegations visited WIHG labs and museum. They have also visited NGF where detailed

deliberation about the joint Indo-Norwegian ongoing project was presented by Dr Vikram Gupta.

Meeting of Indo-Norwegian Project (February 3-4, 2015)

A meeting of Indo-Norwegian Project with an aim to install a ground source heat pump was held at the Wadia Institute of Himalayan Geology (WIHG), Dehradun on February 3-4, 2015. The meeting was chaired by Prof A. K. Gupta, Director, WIHG, and started with his welcome remarks. Dr. Bhasin from Norwegian Geotechnical Institute, Norway; Sh Vijay Chauhan, ISOR, Iceland; Dr. Bhoop Singh from DST; and Drs. S.K. Bartarya, S.K. Rai, Gautam Rawat and Sh C.B. Sharma from Wadia Institute attended the meeting. In the opening remarks the Director emphasised that the collaboration should have two aspects namely research component and technology development towards self-reliance. After the presentation and discussion, the committee members decided that, a borehole will be drilled on the left side of the WIHG guest-house on the way toward the main car parking site, and the GSHP installing will be along the wall where there are no windows, while the Guest house Lounge will be used for space for heating/cooling. The committee members also inspected the guest-house site for the finalization and recommendation of site for drilling.

AWARDS AND HONOURS

- Dr P.K. Mukherjee received *"M. Sita Devi & Rama Rao Medal-2014"* from the Indian Society of Applied Geochemists, Hyderabad for his contribution in Analytical Geochemistry.
- Dr Devajit Hazarika received *'Indian Society of Earthquake Science (ISES) Merit Award for Young Scientist-2015'*. This award was received during the International Symposium on "Reducing Earthquake Losses and Advances in Earthquake Science", held during January 5-7, 2015 at Institute of Seismological Research (ISR), Gandhinagar, Gujarat.
- The paper entitled *'Influence of debris cover on terminus retreat and mass change of Chorabari Glacier, Garhwal Region, Central Himalaya'*, authored by D.P. Dobhal, Manish Mehta and Deepak Srivastava and published in Journal of Glaciology, 59 (21), 961-971 received the *'Wadia Institute Best Paper Award - 2013'*.
- The paper titled *'Quantification of changes in epiglacial morphology and annual mass balance of Dokriani Glacier, central Himalaya, India'*, authored by Bhanu Pratap, D.P. Dobhal, A.K. Gupta, Manish Mehta and R. Bhambri received *'Best Poster Presentation Award'*at National Conference of Himalayan Glaciology (NCHG), held at Shimla on October 30-31, 2014.
- The paper titled *'Hydrogeology of springs around Tehri Reservoir;"* authored by S.K. Bartarya received *'Best Poster Presentation Award'* at the National Seminar on Geo-environmental Hazards and Neo-tectonic activities in Himalaya, held at Department of Geology BadshaiThaul campus, Tehri, H.N.B. Garhwal University on October 28-30, 2014.

VISITS ABROAD

- Sh Aditya Kharya visited California, USA to attend Goldsmith Conference during June 4-7, 2014
- Dr Kishor Kumar visited Brussels, Belgium for developing a project proposal under bilateral research cooperation between India and Belgium, and to study the Eocene vertebrate fossil materials during June14-22, 2014.
- Drs B.N. Tiwari, Sushil Kumar and Kapesa Lokho visited Sapporo, Japan to attend *'11th AOGS Meet'* during July 28th to August 1st, 2014.
- Dr D.P. Dobhal visited ICIMOD, Kathmandu, Nepal to attend a brain storming workshop on *'Himalayan Adaption, Water and Resiliences (HI-AWARE)'* during August 10-14, 2014.
- Dr A. K. Singh visited China as a nominee of the DST, New Delhi to participate in the exposure visit of Indian Scientists to China during August 16-24, 2014.
- Drs Rajesh Sharma, P.K. Mukherjee and Naresh Kumar visited Lucca, Italy to participate in the *'29th Himalayan Karakorum Tibet Workshop'* during September 1-5, 2015. On Institute's behalf Dr Rajesh Sharma also presented the proposal to organize 2015 *'30th Himalayan Karakorum Tibet Workshop'* at WIHG, Dehradun.
- Dr Naresh Kumar during his one year stay at International Centre of Theoretical Physics, Trieste, Italy, visited Kigali, Rwanda to attend *"Workshop on Geophysical Monitoring and Modeling for Sustainable Energy and Geohazard Solution"* during September 16-25, 2014, and delivered a lecture. He also visited San Francisco, USA to attend *"2014 AGU Fall Meeting"* during December15-19, 2014.
- Vikram Gupta visited Bangkok, Thailand to attend a regional meeting under Asian programme for Regional Capacity Enhancement for Landslide Impact Mitigation (RECLAIM) during December 3, 2014
- Dr Pradeep Srivastava visited National University of Singapore (NUS), Singapore to attend a conference *"Future Floods: an exploration of a cross-disciplinary approach to Flood Risk Forecasting"* during February 26-27, 2015, and delivered two lectures.

Ph.D. THESES

Name of Student	Supervisor	Title of the Theses	University	Awarded/ Submitted
Aditya Kharya	Prof. Anil K. Gupta Dr P.K. Mukherjee	Isotopic and Geochemical Studies of the Ladakh Accretionary Prism, North-West Himalaya	University of Petroleum and Energy Studies, Dehradun	Awarded
Megha M. Daga	Dr D.R. Rao Dr Santosh Kumar	Magmatic, metamorphic and crustal evolution of Shyok-Durbuk section, eastern Ladakh, India	Kumaun University, Nainital	Awarded
Rakhi Rawat	Dr Rajesh Sharma Prof. Santosh Kumar	Genesis and economic potential of graphite associated with Almora Crystallines, Kumaun Himalaya	Kumaun University, Nainital	Awarded
Dinesh S. Chauhan	Dr Rajesh Sharma Prof. Santosh Kumar	Thermal structure and resource potential of Chiplakot Crystalline Belt, northeast Kumaun Himalaya, India	Kumaun University, Nainital	Awarded
Matsyendra Kumar Shukla	Dr N. Siva Siddaiah Prof. S.K. Pandita	Field relationship and petrogenesis of the Brecciated unit of Jangalgali Formation, Jammu, India	University of Jammu, Jammu	Awarded
Souvik Das	Dr B.K. Mukherjee	Nature and evolution of mantle section in the Nidar Ophiolite Suite, Ladakh, India	University of Petroleum and Energy Studies, Dehradun	Awarded
Suman Lata Rawat	Prof Anil K. Gupta Prof. H.C. Nainwal	Palynological investigations of peat deposit with respect to the Late Quaternary climate history of the North west Himalaya	H.N.B. Garhwal University, Srinagar	Awarded
Sameer Kumar Tiwari	Dr S.K. Bartarya Dr S.K. Rai	Isotopic and Geochemical Studies of Geothermal Springs of North West Himalayas, India: Implication for Source and Degassing of Metaphoric CO_2	University of Petroleum and Energy Studies, Dehradun	Submitted
Mayank Joshi	Dr V.C. Thakur Dr Y.P. Sundriyal	Climate-tectonic interaction in the morphogenic evolution of Ravi river basin in Chamba region, Western Himachal Pradesh, NW Himalaya	H.N.B. Garhwal University, Srinagar	Submitted
Koushick Sen	Dr B.K. Mukherjee	Formation and Tectonic evolution of Zildat Ophiolitic Melange, Indus Suture Zone, NW Himalaya, India	University of Petroleum and Energy Studies, Dehradun	Submitted
Leena Kamra	Dr V.M. Choubey Prof. R.C. Ramola	Studies of radon and allied Parameters as earthquake precursors in Garhwal Himalaya	H.N.B. Garhwal University,	Submitted

PARTICIPATION IN SEMINARS/SYMPOSIA/ WORKSHOPS/ MEETINGS/ TRAINING COURSES

Brainstorming session on '*Paleoclimate records from the Ganga plain'* at Wadia Institute of Himalayan Geology, Dehrdun during April 3-4, 2014.

Participants: N.K Meena, S. Sarkar, Prakasam M. and S. Rawat

Seminar on *'Retrospect and Prospects of Natural Resources and Disaster Management in Uttarakhand Himalaya'* at Dolphin (PG) Collage Dehradun during April 10-11, 2014.

Participant: D.P. Dobhal

Meeting on *'Ice core programme'*at Indian Institute of Science, Bangalore on April 11, 2014.

Participant: Santosh K. Rai

ISRO-CNES meet on *'Geodynamics of Himalaya'* at the Indian Institute of Remote Sensing (IIRS), Dehradun during June 12-13, 2014.

Participants: G. Philip and R. Jayangondaperumal

Workshop/Conclave on *'Development and Management of Border Road-Problems, Constraints, Challenges and Appropriate Solution*' Central Road Research Institute (CRRI), New Delhi on June 16, 2014.

Participant: D.P. Dobhal

IODP-India pre-cruise Meeting on*'IODP Expedition: 355 (Arabian Sea Monsoon)',* at *National Centre for Antarctic and Ocean Research (NCAOR),* Goa, on June 16, 2014.

Participant: Prakasam M.

Conference on *'Natural Disaster'* organized by the Confederation of Principals of Uttar Pradesh, Lucknow at WIHG, Dehradun during June 16-17, 2014.

Participant: P.S. Negi

Workshop on *'Scientific Paper Writing and Technological Empowerment of Women'* at Graphic Era University, Dehradun during June 17-18, 2014.

Participant: Kapesa Lokho

Workshop of *'29th Himalaya-Karakoram-Tibet (HKT)*' at Lucca, Italy during September 2-4, 2014.

Participants: Rajesh Sharma, P.K. Mukherjee and Naresh Kumar

Conference on *'Climate Change and Environmental Sustainability: Records from Poles to Tropics*' at Lucknow University, Lucknow during September 9-10, 2014.

Participant: P. Srivastava

Workshop on *'Geophysical monitoring and Modeling for Sustainable Energy and Geohazard Solution'* at Kigali, Rwanda during September 16-25, 2014.

Participant: Naresh Kumar

Conference on *'Convention on climate change and water 2014'* at Gyan Vihar University, Jaipur, Rajasthan during September 24-26, 2014.

Participant: N.K Meena

Thermo Fisher IOMS-meet at Jaipur during September 24-26, 2014.

Participant: Santosh K. Rai

Workshop on *'Reconstruction, development and livelihood enhancement in disaster affected area of Kedar valley'* at G.B Pant Institute of Himalayan Environment and Development (GBPIHED), Almora during September 29-30, 2014.

Participant: D.P. Dobhal

National Seminar on *'Geo-environmental hazards and Neotectonic activities in Himalaya'* at Dept of Geology, HNB Garhwal University (Badshai Thaul campus) Tehri Garhwal during October 28-30, 2014.

Participant: S.K. Bartarya

National Conference on *'Himalayan Glaciology (NCHG-2014)'*at Himachal Pradesh State Council for Science, Technology & Environment, Shimla, during October 30-31, 2014.

Participants: D.P. Dobhal, Reet Kamal, Archna Bohra, Bhanu Pratap and Kapil Kesarwani

National Workshop on *'Status of Natural Hazards in Himachal Pradesh (NHHP)'* at Central University Himachal Pradesh, Dharamshala during November 6-8, 2014.

Participant: M.P. Parija

National Conference on *'Emerging Trends in Engineering and Technology (ETET-2014)'* at Dev

Bhoomi Group of Institutions, Dehradun during November 7, 2014.

Participant: G. Philip

Working Group Meeting of *'National Institute of Hydrology (NIH)'*, Roorkee during November 27-28, 2014.

Participant: S.K. Bartarya

International Conference on *'Advances in Computing, Communications and Informatics (ICACCI-2014)'* at College of Engineering, Roorkee during November 28-29, 2014.

Participant: T.N. Jowhar

Brainstorming session on *'ULF/VLF/GPS/TEC based studies of precursory phenomenon associated with earthquakes'* at RBS College, Agra, during November 28-29, 2014.

Participant: G. Rawat

49th Annual Convention of the Computer Society of India & International Conference on '*Emerging ICT for Bridging Future'* at Jawaharlal Nehru Technological University (JNTU), Hyderabad during December 12-14, 2014.

Participant: T.N. Jowhar

National Conference on *'Advances in chemical sciences with special reference to molecular spectroscopy, material science and organic electronics NCACS-2014'* at Fergusson College, Pune during December 19-20, 2014.

Participant: R. Islam

International Conference on *'Soft Computing for Problem Solving (SocProS 2014)'* at NIT, Silchar, Assam during December 27-29, 2014.

Participant: Sushil Kumar

'102nd Indian Science Congress' at University of Mumbai, Mumbai during January 3-7, 2015.

Participant: T.N. Jowhar

International Symposium on *'Reducing earthquake losses and advances in earthquake science-2015'* at Institute of Seismological Research (ISR), Gandhinagar, Gujarat during January 5-7, 2015.

Participant: D. Hazarika

International Symposium on *'Transforming Mountain Forestry'* at Forest Research Institute, Dehradun during January 18-22, 2015.

Participant: P.S. Negi

Meeting of the National Mission on *'Sustainable Himalayan Ecosystem (NMSHE)'* at DST, New Delhi on February 05, 2015.

Participants: S.K. Bartarya, D.P. Dobhal and Vikram Gupta

'54th Central Geological Programming Board meeting' of Geological Survey of India at New Delhi., during February 5-6, 2015.

Participant: Rajesh Sharma

'Bhartiya Vigyan Sammelan' at Goa during February 5-8, 2015.

Participant: Santosh Rai

Working Group Committee meeting on *'Lake Outburst Flood; South Lhonak Lake, Sikkim Himalaya'* at Indian Institute of Science (IISc), Bengaluru on February 21, 2015.

Participant: D.P. Dobhal

IIRS User Interaction Meet (IUIM-2015) on *'Recent Advances in Geospatial Technologies'* at Indian Institute of Remote Sensing (IIRS), Dehra Dun, during February 26-27, 2015.

Participant: G. Philip

Workshop on *'Intergovernmental Panel on Climate Change (IPCC)'s Fifth Assessment Report (AR5) Uttarakhand Outreach Event'* at Forest Research Institute, Dehradun on March 10, 2015.

Participant: D.P. Dobhal

Working Group Meeting of National Institute of Hydrology (NIH), Roorkee during March 19-20, 2015.

Participant: S.K. Bartarya

National Seminar on *'Recent Development and Challenges in Geochemistry (GEOCHEM 2015)'* at Annamalai University during March 26-27, 2015.

Participant: P.K. Mukherjee

'Urja Sangam-2015' at New Delhi on March 27, 2015.

Participants: Prakasam, M., S.L. Rawat, A. Bhandari, Smita Gupta and Vipin Kumar

LECTURES BY INSTITUTE SCIENTISTS

Name of Scientist	Venue	Date	Topic
Vikram Gupta	Uttarakhand Secretariat, Dehradun	30.04.2014	Slope stabilization using facilities developed at NGF
Anil K. Gupta	Birla Institute of Advanced Applied Sciences, Bhimtal, Nainital	29.05.2014	Climate Extremes and Kedarnath Disaster
Pradeep Srivastava	National Physical Laboratory, New Delhi	29.05. 2014	Application of Luminescence dating in understanding the evolution of Himalaya
Rajesh Sharma	Kumaun University, Nainital	05-06.06.2014	Lectures on 'Economic Geology'
Vikram Gupta	Forest Research Institute, Dehradun	07.06.2014	Landslide hazards and related issues in Uttarakhand Himalaya
Vikram Gupta	Forest Research Institute, Dehradun	08.07.2014	Landslide factors, causes and their management in the Himalaya
P.S. Negi	Central Soil and Water Conservation Research and Training Institute, Dehradun	21.07.2014	Investigation on hydro meteorological disaster in Himalaya: a case study of Mandakini Valley Catastrophe of June 2013
P.K. Mukherjee	Archaeological Survey of India, Dehradun	21.08.2014	i) Rocks & Minerals ii) Weathering of Building stones
N. Suresh	Archaeological Survey of India, Dehradun	21.08.2014	Luminescence dating
D.P. Dobhal	Jawaharlal Nehru University, New Delhi	28.08.2014	i) Glacier research in India; an overview ii) Glacier monitoring; Principal techniques and tools
P.S. Negi	Unison University, Dehradun	09.09.2014	Natural Disaster in Himalaya
Vikram Gupta	WIHG, Dehradun	18/19.09.2014	Application for engineering geology for tunnelling
Naresh Kumar	International Centre of Theoretical Physics (ICTP), Trieste, Italy	18.10.2014	Investigation of sub-surface structure in the western part of Himalaya-Tibet collision using Seismic tomography
Vikram Gupta	National Geotechnical Facility, Dehradun	10.11.2014	Geotechnical properties of rocks and soil vis-à-vis landslide

S.K. Bartarya	Military Engineering Services, Dehradun Cantt	19.11.2014	Geomorphology - Himalayan landforms and related hazards
Vikram Gupta	Asian Disaster Preparedness Centre, Bangkok	03.12.2014	Landslide disasters in the Himalayan region with special reference to the 2013 Uttarakhand disaster
Vikram Gupta	WIHG and NGF, Dehradun	10.12.2014	DST-NGI (ICG) Institution cooperation on mitigation of geohazards in India
Vikram Gupta	SDRF Vahini, Dehradun	10.12.2014	Geological and Geomorphological set up along with associated hazards of Uttarakhand Himalaya
Vikram Gupta	University of Petroleum and Energy Studies, Dehradun	17.12.2014	Series of lectures on rock mechanics and landslide studies
Anil K. Gupta	INSA Annual Meeting NIO, Goa	19.12.2014	Abrupt Changes in Summer Monsoon precipitation in India since MIS3
D.P. Dobhal	Forest Research Institute, Dehradun	04.02.2015	Climate change impact on glaciers - observation and facts
Anil K. Gupta	Bhartiya Vigyan Sammelan & Expo Goa, organized by University of Goa	06.02.2015	Extreme Changes in Indian Summer Monsoon and Adaptation Strategies
Anil K. Gupta	ISM, Dhanbad	11.02.2015	Prof. N.L. Sharma Memorial Lecture on “Evolution of the South Asian Monsoon and Extreme Events”
S.S. Thakur	Kumaun University, Nainital	20-22.03.2015	Lectures on Metamorphic Petrology
N.K. Saini	Gurukul Kangri University, Haridwar	31.03.2015	X-ray analytical techniques for the characterization of materials

MEMBERSHIP

Bhakuni, S.S.	:	Elected Executive Member of the Indian Geological Congress (IGC) Executive Council, Roorkee for the year 2014-15
Jowhar, T.N.	:	• Elected Chairman, Computer Society of India, Dehradun Chapter for the year 2014-15 • Elected as Member of the National Academy of Sciences, India • Elected as President of the section of Earth System Sciences for 2015-16 of 103rd Indian Science Congress • Elected as Council Member of the Mineralogical Society of India for 2015-17
Kumar, Kishor	:	Member Executive Council, Palaeontological Society of India (2014-15)
Kumar, Naresh	:	Regular Associate of International Centre of Theoretical Physics (ICTP), Trieste, Italy since 2014
Kumar, Sushil	:	• Member of Seismological Society of America (SSA), for the year 2014-15 • Member of Japan Geoscience Union, Japan for the year 2014-15
Philip, G.	:	Member Executive Council ISRS (Dehradun Chapter) (2014-16)
Singh, A.K.	:	Elected Executive Member of the Indian Geological Congress (IGC) Executive Council, Roorkee for the year 2014-15

PUBLICATION AND DOCUMENTATION

The Publication & Documentation section during this year brought out the publications of (i) 'Himalayan Geology' volumes 35(2) and 36(1), (ii) 'Annual Report' of the Institute for the year 2013-14 in Hindi and English, (iii) Hindi magazine 'Ashmika' volume 20, (iv) Newsletter 'Bhugarbh Vani' volumes 4 (Nos. 1-4) and 'Drishtikon' volume 3(1). Apart from this, works pertaining to printing of certificates etc., are also taken-up. Section was also involved in dissemination of the publications to individuals, institutions, life time subscribers, book agencies, national libraries, indexing agencies, under exchange program and maintaining the sale & accounts of publications. The section also provides the technical support services of printing and scanning to Scientists, Research Scholars and other Staff of the Institute.

Himalayan Geology (journal) website http://www.himgeology.com is functioning with online enquiry, online prepaid subscription order and online manuscript submission facility is also taken care by the Publication and Documentation section. All information regarding the journal including contents and abstracts is up-to-date on the website. The 'Himalayan Geology' is indexed in Thomson Reutors (US), SCOPUS (Elsevier, Netherlands) and in Indian Citation Index (ICI) New Delhi. The Impact Factor for the year 2013 was 0.314 (source: Thomson Reutors). Under the Life Time Subscriber Scheme (LTSS) Membership for Himalayan Geology (journal), 20 new members got registered; bring the total registered number to 442.

LIBRARY

The Library of Wadia Institute of Himalayan Geology is a unique Library consisting of finest collection of books, monographs, journals, and e-books etc on the mountain building process, geological and geophysical phenomenon with special reference to the Himalaya. The collection and services offered makes it one of the best libraries in the field of earth science in the country. The library has always been as a best information access support to them in their endeavour to highly specialized activities. Specialists and professionals from all across the country also visit this library to utilize the specialized and rare collections available and other services provided by this library.

The Library subscribed to 84 Foreign and 44 Indian journals. A total number of 80 reference books are purchased and 3 books are received as gratis. In addition to this a total number of 114 Hindi books are purchased. The library has 5000+ carefully selected e-books from different publishers and learned societies. During 2014-15 the existing collections are updated and some new e-books collections are purchased. The new e-books collections added are: Earth and Environmental Science e-books published during the year 2012-2014, Earth and Planetary Science e-books published during 2013-2014 including series titles, 151 titles from Wiley's Earth and Environmental Science subject collection, and archive of AGU publications consisting of 616 titles. The Library has also purchased the back files collection of Nature journal from 1997 to 2006.In addition to this, many publishers contribute online access to more than four hundred journals' titles, other than subscribed by us.

The digitised articles were added to the Institutional Repository created using DSpace (OSS) for organizing and disseminating the research output of the Institute. The articles published by institute scientists in various journals were also taken for digitisation purpose, till date 1660 PDF files of scientists' publication are digitised.

The Library has the small hub of computers for accessing the e-books and e-journals and Internet surfing and the other e-resources available, either subscribed by WIHG Library or available through the National Knowledge Resource Consortium (NKRC). The library also serves as central facility for the photocopying work of the Institute.

S.P. NAUTIYAL MUSEUM

Institute Museum named after Prof. S. P. Nautiyal, remains the main center of attraction for national and international visitors. During this year more than 2,500 people visited the Museum from the different parts of India, and from other countries like Switzerland, USA, Norway, Italy, Canada, France, United Kingdom, Austria, Australia and Russia. The visitors include the students in large numbers from different schools, universities, colleges and other institutions. In addition, army and ITBP cadets, the general public and tourists also visited the museum. A number of students also visit the museum for their respective school projects on Earthquake and geology related topics.

Open Day's were observed during National Technology Day, Foundation Day, Founder's Day and National Science Day wherein the Museum is kept open for visitors. Open Days for public are given wide coverage through print media as a result a large number of people from the general public visited the museum on these occasions. Brochures containing important information regarding the Institute activities, and the "*Do and Dont's"* during and after earthquake are published in bilingual language (English and Hindi) and are provided free of cost to the visitors.

A new model of extinct species of Giraffe prepared from waste material is kept for display to the general public in the WIHG lawn. It not only gives interesting and important information regarding the extinct species of the Giraffe but also sends out message of saving the environment. The exhibit not only became a centre of attraction with the media but has also been appreciated during the science outreach programme by the general public and by the dignitaries who visited the Institute.

A view of the exhibits displayed in the S.P. Nautiyal Museum

TECHNICAL SERVICES

Analytical Services

During this period a total number of four thousand five hundred and fifty eightsamples were analyzed for different elements using XRF, XRD, SEM, ICPMS and water chemistry lab.

Lab. / Technique	Samples analysed		
	WIHG Users	Outside Users	Total
XRF	973	807	1780
ICP-MS	966	882	1848
SEM-EDX	170	235	405
XRD	201	192	393
Water Chemistry	110	22	132
Total samples analysed			4558

Photography Section

The Photography Section cover various functions organized in the Institute during the year 2014-2015 and clicked around 6000 images using digital cameras. The functions covered include, Foundation Day, Founders Day, National Science Day, National Technology Day, New Years Day, Seminars/ Symposia, and superannuation parties of the Institute Staff etc. Apart from this around 800 snaps were clicked for rock and fossil specimens. The colour printing of around 300 digital images was arranged from the market. No new cameras were purchased during the reporting year as a great majority of scientists already have cameras issued permanently to them for use in the field and laboratory. Other scientists and research scholars are provided cameras from a pool as and when they require it.

Drawing Section

The Drawing Section catered to the cartographic needs of the Scientists of the Institute including the sponsored projects. During 2014-15, the section has provided 23 geological maps / structural maps / geomorphological maps / seismicity diagrams for the scientists and research scholars of the Institute, besides the tracing of thirty topographic sheets/ aerial photo maps and four geological columns have been prepared. The section has also provided name labels, thematic captions during different activities and functions of the Institute including writing work on the photo identity cards of the employees of the Institute.

Sample Preparation Laboratory

The sample preparation laboratory provided thin/microprobe/ polished sections to the requirements of the Institute Scientists and Research Scholars. During the reporting year the laboratory provided 1176 thin and polished sections to various users for carrying out microscopic, fluid inclusion and EPMA studies. The laboratory also processed crushing/grinding of 1356 rock samples for carrying out major, trace and REE analysis by ICPMS, XRF and XRD methods.

CELEBRATIONS

Foundation Day Celebrations

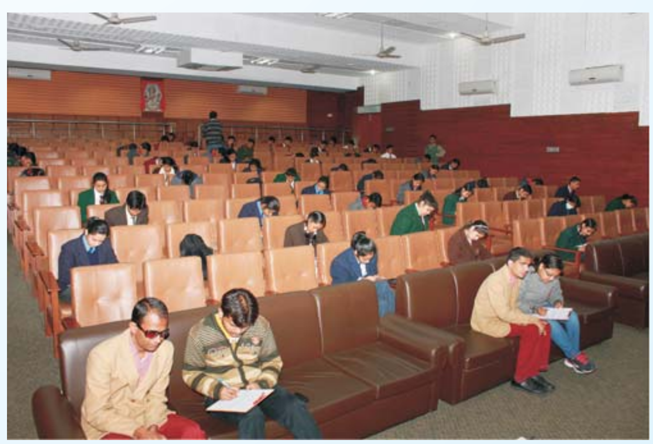
The Institute celebrated the '*46^{th} Foundation Day*' on June 29, 2014. The Chief Guest on this occasion was Prof. S.K. Dube, Former Director IIT, Kharagpur. He delivered the 'Foundation Day Lecture' on *'Storm Surge Prediction in the North Indian Ocean'*. The occasion was also marked by distribution of awards by Chief Guest to the best research papers published by the Institute scientists as well as to the best workers in the various categories of the Institute. The Best Paper award was given to Drs. D.P. Dobhal, Manish Mehta and D. Srivastava for their paper published in Journal of Glaciology. The best workers awards for the good work carried out during the year 2014-15 were given to Sh. M.M.S. Rawat (STO), Sh. A.K. Pandit (Sr. Artist-cum-modeller), Sh. Chandershekhar (STO), Sh. T.K. Ahuja (JTO), Sh. Rambir Kaushik (Asstt. Publication & Doc. Officer), Dr. Jitender Bhatt (STA-EDP), Sh. Pankaj Chauhan (JTO), Sh. S.S. Bhandari (STA), Sh. Rakesh Kumar (TA), Sh. C.P. Dabral (SLT), Sh. S.S. Bisht (Accountant), Km. Richa Kukreja (Stenographer G-III), Sh. S.K. Chetri (Assistant), Sh. Rahul Sharma (UDC), Sh. Rajeev Yadav (LDC), Sh. Gisrish Chander Singh (LDC), Sh. Neeraj Bhat (LDC-on contract), Sh. Nand Ram (Sr. Electrician-cum-Pump Operator), Sh. Balram Singh (Sr. Electrician-cum-Pump Operator), Sh. Shekhranandan (Section Cutter), Sh. Naindas (Lab Assistant), Sh. Sanjiv Kumar (Field-cum-Lab Attendant), Sh. R.S. Negi (Field Attendant), Sh. Madhusudan (Field-cum-Lab Attendant), Sh. Khushi Ram (Field Attendant), Sh. Rajesh Yadav (Driver-on contract), Sh. Bhupender Kumar (Driver-on contract), Sh. Manmohan (Driver-on contract), Sh. Rudra Chetri (Bearer-on contract), Sh. Chet Ram (Bearer), Sh. Ramesh Chand Rana (MTS), Sh. Harish Kumar Varma (Bearer-on contract), Sh. Rohlu Ram (Chowkidar), Sh. Satyanarayan (Mali), and Sh. Harikishan (Safaiwala).

National Science Day Celebrations

The Institute organized week long activities as part of the *'The National Science Day-2015'*. Various educational institutions of Dehradun were invited for participation in the Science Quiz and Hindi Essay Competitions. Besides these, Hindi and English slogan competition was also held in which scientists, staff and research scholars participated. To encourage the participation, the winners were awarded with the citation and token cash prizes.

The Institute observed Open Day on the National Science Day i.e. February 28, 2015. On this day all the laboratories were kept open to students and public. A large number of school and college students, and other public from Dehradun regions visited the Institute Laboratories. Scientists as well as the technical staff and research scholars explained the functioning of the various scientific instruments and its uses to the visitors. Museum was kept open for the visitors, in which various exhibits related to the Himalayan glaciers, Earthquakes, Landslides, Origin of Life, Volcanoes, Rocks Minerals, etc., were displayed.

Prof. S. K. Dube, Former Director IIT, Kharagpur occupying the dais along with Prof. A.K. Gupta, Director, WIHG and Dr. V.C. Tewari, Scientist 'G' on the '*46^{th} Foundation Day*'.



School children including the students from the blind school participating in the essay competition organized by the Institute in view of National Science Day.

Exhibits in the Museum are being explained to the school children and their teachers by a research scholar on National Science Day

An invited 'National Science Day Lecture' was delivered by distinguished scientist Prof. S.K. Tandon, D.N. Wadia Chair Professor, IIT, Kanpur on *'Exploration of the Martian surface environments: dawn of sedimentology on our neighbouring planet'*. The lecture was attended by a large number of students of different schools, public and by the Institute staff. The occasion was also marked by distribution of prizes to the winners of the Science Quiz and Hindi Essay competitions.

Prof. S.K. Tandon the Chief Guest delivering the 'Science Day Lecture'.

Science Good Governance Day (Sushasan Diwas)

The Institute celebrated *'Good Governance Day (Sushasan Diwas)'* on December 25, 2014. On this occasion the Institute organized an essay competition for its employees, research scholars and project staff. The title of the essay is 'Good Governance/Sushasan'. Participants were given choice to write either in English or Hindi. The best three essays were awarded prizes on January 26, 2015.

DISTINGUISHED VISITORS TO THE INSTITUTE

- Sushri Uma Bharati Minister for Water Resources, Government of India
- Dr. R. Chidambaram, Principal Scientific Adviser to the Government of India & Chairman, SAC-C
- Shri Mari Blake Oiseth Ministry of Education and Research Oslo, Norway
- Prof. Peter D. Clift, Department of Geology and Geophysics, Louisiana State University, Baton Rouge, USA
- Prof. Tina M. Niemi, University of Missouri, Kansas City, USA
- Maj. T K E Madawalapsc. SLSR, Sri Lanka Army, Sri Lanka
- Shri Marzel Paslal EKA Panjikapt Nizar Indonesia Military academy
- Shri Amarjit Singh, DIG, BSF Academy, SIS Wing, Tekanpur, Gwalior, M.P
- Shri Jayant Shrikant Sahasrabudhe Vigyan Bharti

Dr. R. Chidambaram, Principal Scientific Adviser to the Government of India & Chairman, SAC-C.

Sushri Uma Bharati Minister for Water Resources, Government of India

STATUS OF IMPLEMENTATION OF HINDI

During the year under report, efforts for progressive use of Hindi was continued. The scientists and staff of the Institute were time and again apprised with the various orders and constitutional provisions of official Language Act to increase awareness for progressive use of Hindi in day-to-day work. Various incentive schemes for encouraging progressive use of Hindi were implemented. General orders, circulars and notices were issued in Hindi as well as in English. Orders/decisions regarding use of Hindi received from the Government of India from time to time were circulated to all the concerned officers in the Institute for compliance.

Hindi Pakhwara was celebrated in the Institute from September 14-28, 2014 during which Essay competition and Debate for school children and Institute employees were organized. Prof. V.K. Jain, Vice-Chancellor, Doon University was Chief Guest on the occasion and inaugurated Hindi Pakhwara. During 'Hindi Pakhwara' seven lectures were organized, wherein eminent scientists and other experts gave invited talks on various topics. Apart from the Wadia Institute scientists the invited speakers from outside included: Shri Chandi Prasad Bhatt, Shri Buddhi Nath Mishra, Shri Dinesh Chamola and Shri Hemwati Nandan Pandey. The Institute scientists and other employees also took keen interest and delivered their specialized talks. These were Dr. Ajay Paul, Dr. P.S. Negi, Dr. Santosh K Rai, Dr. Narendra Meena, Shri Harish Chandra, Shri Tajendra Ahuja and Km. Jooly Jaiswal. The valedictory talk was delivered by Dr. Suchismita Pande. A Hindi 'Kavya Goshthi' was also organized during the 'Hindi Pakhwara' and invited poets of national repute Shri Kunwar Bechain, Shri Sanjay Jhala, Shri Sarvesh Asthana, Shri Praveen Agri and Shri Vineet Chauhan graced the occasion. Swarachit Kavita Path was also organized for Institute employees on this occasion.

Prof. V.K. Jain, Vice-Chancellor, Doon University addressing during the inauguration ceremony of the Hindi Pakhwara.

The Annual Report of the Institute for the year 2013-14 was published in Hindi and English. On the occasion of the '46th Foundation Day' of the Institute on June 29, 2014 the Hindi Magazine 'Ashmika' volume 20 was released. The Institute Library has also got good collection of Hindi books for promotion of Hindi among the Institute staff. This section consists of more the 2866 books consisting of poetry, drama, literature, short stories and novels by eminent authors on wide range of subjects. During the reporting period a total number of 114 books were added to the Hindi books collection.

School children participating in the essay competitions organized by the Institute during Hindi Pakhwara.

Hindi Magazine 'Ashmika' being released by Prof. S.K. Dube, Former Director IIT, Kharagpur.

MISCELLANEOUS ITEMS

1. Reservation/Concessions for SC/ST employees

Government's orders on reservations for SC/ST/OBCs are followed in recruitment to posts in various categories.

2. Monitoring of personnel matters

Monitoring of personnel matters relating to employees of the Institute is done through various committees appointed by the Director/Governing Body from time to time.

3. Mechanism for redressal of employee's grievances

There is a Grievance Committee consisting of four Senior Scientists/Officers for redressal of employee's grievances. No request regarding grievance of any of the employee was received during the year by the Grievance Committee.

4. Welfare measures

The Institute has various welfare measures for the benefit of its employees. Various advances like House Building Advance, Conveyance Advance, Festival Advance, etc. are given to the employees. There is a salary Earner's Cooperative Society run by the Institute employees that provide loans to its members as and when required. The Institute also runs a canteen for the welfare of the employees. As a welfare measure, the Institute is providing recreational facilities to its employees.

5. Mechanism for redressal of complaints of sexual harassment of women employees at work places.

To inquire into the complaints of sexual harassment of women employees at work places in the Institute, a separate Committee has been constituted. The Committee consists of six members. The Chairman and two other members of the Committee are female officers, which includes a female officer from the Geological Survey of India. No complaint of sexual harassment of women employees at work places was received by the Committee during the year 2014-15.

6. **Status of Vigilance Cases**

No vigilance case was either pending or was contemplated against any of the employee of the Institute during the year 2014-15.

7. Information on the RTI cases

Two applications for seeking information and one appeal under the Right to Information Act, 2005 were carried forward from the previous year 2013-14.

The details of information on the RTI cases during the year 2014-15 are as under:

Details	Opening balance as on 01.04.2014	Received during the year 2014-2015	Number of cases transferred to other public authorities	Decisions where requests/ appeals were rejected	Decisions where requests/ appeals accepted
1	2	3	4	5	6
Requests for information	02	17*	Nil	Nil	17
First appeals	01	Nil	Nil	01	Nil

*Two applications under the Right to Information Act, 2005 were carried forward to the next financial year 2015-16.

8. Sanctioned Staff strength (category wise)

Group/ Category	Scientific	Technical	Administrative	Ancillary	Total
A	63	-	2	-	65
B	-	2	6	-	8
C	-	65	30	40	135
Total	63	67	38	40	208

9. Sanctioned and released budget grant for the year 2014-2015

Plan : Rs. 2,836.18 lakhs

Non-Plan : Rs. 39.15 lakhs

Total : Rs. 2,875.33 lakhs

STAFF OF THE INSTITUTE AS ON 01.04.2014

Scientific Staff

1. Prof. Anil Kumar Gupta	Director
2. Dr. V.C. Tewari	Scientist 'G' (Retired on 30.11.14)
3. Dr. Rohtash Kumar	Scientist 'G'
4. Dr. P.P. Khanna	Scientist 'G'
5. Dr. (Mrs.) Meera Tiwari	Scientist 'G'
6. Dr. N.K. Saini	Scientist 'G'
7. Dr. Rafikul Islam	Scientist 'G'
8. Dr. S.K. Ghosh	Scientist 'G'
9. Dr. Kishor Kumar	Scientist 'G'
10. Dr. Rajesh Sharma	Scientist 'G'
11. Dr. G. Philip	Scientist 'G'
12. Dr. B.N. Tiwari	Scientist 'G'
13. Dr. D. Rameshwar Rao	Scientist 'G'
14. Dr. P.K. Mukharjee	Scientist 'G'
15. Dr. Keser Singh	Scientist 'F'
16. Dr. S.K. Bartarya	Scientist 'F'
17. Dr. T.N. Jowhar	Scientist 'F'
18. Dr. S.K. Parcha	Scientist 'F'
19. Dr. H.K. Sachan	Scientist 'F'
20. Dr. Sushil Kumar	Scientist 'E'
21. Dr. A.K. Mahajan	Scientist 'E' (On Lien)
22. Dr. D.P. Dobhal	Scientist 'E' (On Deputation)
23. Dr. Vikram Gupta	Scientist 'E'
24. Dr. Suresh N.	Scientist 'E'
25. Dr. Pradeep Srivastava	Scientist 'E'
26. Shri V. Sriram	Scientist 'D'
27. Dr. A.K. Mundepi	Scientist 'D' (Retired on 31.03.15)
28. Dr. Ajay Paul	Scientist 'D'
29. Dr. S.S. Bhakuni	Scientist 'D'
30. Dr. P.S. Negi	Scientist 'D'
31. Dr. A.K.L. Asthana	Scientist 'D'
32. Dr. R. Jayangondaperumal	Scientist 'D'
33. Dr. A.K. Singh	Scientist 'D'
34. Dr. (Ms) Kapesa Lokho	Scientist 'D'
35. Dr. Khaying Shing Luirei	Scientist 'D'
36. Dr. Gautam Rawat	Scientist 'D'
37. Dr. Rajesh S.	Scientist 'C'
38. Dr R.K. Sehgal	Scientist 'C'
39. Dr. Jayendra Singh	Scientist 'C'
40. Dr. B.K. Mukherjee	Scientist 'C'
41. Dr. Naresh Kumar	Scientist 'C'
42 Dr.(Mrs) Swapnamita Ch.	Scientist 'C'
43. Dr. Santosh Kumar Rai	Scientist 'C'
44. Dr. Devajit Hazarika	Scientist 'C'
45. Dr. Narendra K. Meena	Scientist 'C'
46. Dr. Dilip Kumar Yadav	Scientist 'C'
47. Dr. Param K.R. Gautam	Scientist 'C'
48. Dr. Kaushik Sen	Scientist 'C'
49. Dr. Satyajeet S. Thakur	Scientist 'C'
50. Dr. Manish Mehta	Scientist 'C'
51. Dr. (Ms.) Aparna Shukla	Scientist 'C'
52. Dr Sudipta Sarkar	Scientist 'B'
53. Sh. M. Prakasam	Scientist 'B'
54. Dr. Vikas	Scientist 'B'
55. Sh. Som Dutt	Scientist 'B'
56. Sh. Anil Kumar	Scientist 'B'
57. Sh. Saurabh Singhal	Scientist 'B'
58. Dr. Narendra Kumar	Scientist 'B'
59. Sh. Vinit Kumar	Scientist 'B'

Technical Staff

1. Shri Saeed Ahmad	Sr. Librarian, Gr. III(5)
2. Shri A.K. Pandit	Sr. Artist cum Modellor, Gr. III(5) (Retired on 28.02.2015)
3. Shri B.B. Sharma	Sr. Tech. Officer, Gr. III(5)
4. Shri M.M.S. Rawat	Sr. Tech. Officer, Gr. III(5)
5. Shri Sanjeev K. Dabral	Sr. Tech. Officer, Gr. III(5)
6. Shri Chandra Shekhar	Sr. Tech. Officer, Gr. III(5)
7. Shri Samay Singh	Sr. Tech. Officer, Gr. III(5)
8. Shri S.C. Kothiyal	Sr. Tech. Officer, Gr. III(5)
9. Shri Rakesh Kumar	Tech. Officer, Gr. III(4)
10. Shri Ravindra Singh	Tech. Officer, Gr. III(4)
11. Shri H.C. Pandey	Tech. Officer, Gr. III(4)
12. Shri N.K. Juyal	Tech. Officer, Gr. III(4)
13. Shri T.K. Ahuja	Jr. Tech. Officer, Gr. III(3)
14. Shri C.B. Sharma	Asstt. Engineer, Gr. III(3)
15. Shri S.S. Bhandari	Asstt. Librarian, Gr. III(3)
16. Shri Rambir Kaushik	Asstt. Pub.&Doc. Officer,Gr.III(3)
17. Dr. Jitendra Bhatt	Sr. Tech. Asstt. (EDP), Gr. III(2)
18. Shri Bharat Singh Rana	Sr. Tech. Assistant, Gr. III(2)
19. Shri Pankaj Chauhan	Sr. Tech. Assistant, Gr. III(2) (On Deputation)
20. Shri Lokeshwar Vashistha	Sr. Lab. Technician, Gr. III(2)
21. Dr. S.K. Chabak	Sr. Lab. Technician, Gr. III(2)
22. Shri R.M. Sharma	Sr. Lab. Technician, Gr. III(2)
23. Shri C.P. Dabral	Sr. Lab. Technician, Gr. III(2)
24. Shri V.K. Kala	Draftsman, Gr. II(5) (Retired on 28.02.2015)
25. Shri Navneet Kumar	Draftsman, Gr. II(5)
26. Shri B. B.Saran	Draftsman, Gr. II(5)
27. Shri Tarun Jain	Draftsman, Gr. II(1)
28. Smt. Sarita	Tech. Assistant, Gr. III(I)
29. Sh. Rakesh Kumar	Tech. Assistant, Gr. III(1)
30. Shri S.K. Thapliyal	Sr. Lab. Assistant, Gr. II(5)
31. Shri Shiv Pd. Bahuguna	Sr. Lab. Assistant, Gr. II(5)
32. Shri Sashidhar Pd. Balodi	Sr. Lab. Assistant, Gr. II(5)

33. Shri Rajendra Prakash	Sr. Lab. Assistant, Gr. II(5)
34. Shri A.K. Gupta	Sr. Lab. Assistant, Gr. II(5)
35. Shri Tirath Raj	Sr. Lab. Asstt. (Photo.) Gr. II(5)
36. Shri Nand Ram	Sr. Elect-cum-Pump.Opt., Gr.II(5)
37. Shri Balram Singh	Sr. Elect-cum-Pump Opt.,Gr. II(5)
38. Shri Shekhranandan	Section Cutter, Gr. II(5)
39. Shri Santu Das	Section Cutter, Gr. II(5)
40. Shri Puneet Kumar	Section Cutter, Gr. II(1)
41. Shri Rahul Lodh	Lab Assistant, Gr. II(3)
42. Shri Nain Das	Lab. Assistant, Gr. II(2)
43. Shri Pratap Singh	F.C.L.A., Gr. I(4) (Retired on 31.01.2015)
44. Shri Ram Kishor	F.C.L.A., Gr. I(4)
45. Shri Ansuya Prasad	F.C.L.A., Gr. I(4)
46. Shri Madhu Sudan	F.C.L.A., Gr. I(4)
47. Shri Hari Singh Chauhan	F.C.L.A., Gr. I(4)
48. Shri Ravi Lal	F.C.L.A., Gr. I(4)
49. Shri Preetam Singh	F.C.L.A., Gr. I(3)
50. Mrs. Rama Pant	Field Attendant, Gr. I(3)
51. Shri R.S. Negi	Field Attendant, Gr. I(3)
52. Shri Ramesh Chandra	Field Attendant, Gr. I(3)
53. Shri Khusi Ram	Field Attendant, Gr. I(3)
54. Shri Tikam Singh	Field Attendant, Gr. I(3)
55. Shri Bharosa Nand	Field Attendant, Gr. I(3)
56. Shri B.B. Panthri	Field Attendant, Gr. I(3)
57. Shri M.S. Rawat	Field Attendant, Gr. I(3)
58. Shri Sanjeev Kumar	F.C.L.A., Gr. I(1)
59. Shri Deepak Tiwari	F.C.L.A., Gr. I(1)
60. Shri Ajay K. Upadhaya	F.C.L.A., Gr. I(1)
61. Km. Sangeeta Bora	F.C.L.A., Gr. I(1)
62. Sh. Deepak Kumar	F.C.L.A., Gr. I(1)

Administrative Staff

1. Shri Dinesh Chandra	Registrar
2. Shri Harish Chandra	Fin. & Accounts Officer
3. Shri A.S. Negi	Administrative Officer
4. Mrs. Manju Pant	Asstt. Fin. & Acctts. Officer
5. Shri Manas Kumar Biswas	Store and Purchase Officer
6. Shri Hukam Singh	Office Superintendent
7. Shri S.S.Bisht	Accountant (Retired on 31.03.15)
8. Mrs. Sharda Sehgal	Assistant
9. Mrs. Shamlata Kaushik	Assistant (Hindi)
10. Shri M.C. Sharma	Assistant
11. Shri S.K. Chhettri	Assistant
12. Shri Vinod Singh Rawat	Assistant
13. Smt. Rajvinder K. Nagpal	Stenographer, Grade-II
14. Km. Shalini Negi	Stenographer, Grade-II
15. Km. Richa Kukreja	Stenographer, Grade-III
16. Shri S.K. Srivastava	U.D.C
17. Mrs. Prabha Kharbanda	U.D.C.
18. Shri R.C. Arya	U.D.C.
19. Mrs. Kalpana Chandel	U.D.C.
20. Mrs. Anita Chaudhary	U.D.C.
21. Shri Shiv Singh Negi	U.D.C.
22. Mrs. Neelam Chabak	U.D.C.
23. Mrs. Seema Juyal	U.D.C.
24. Mrs. Suman Nanda	U.D.C.
25. Shri Rahul Sharma	U.D.C.
26. Shri Kulwant S. Manral	U.D.C.
27. Sh. Vijai Ram Bhatt	L.D.C.
28. Shri Girish Chandra Singh	L.D.C.
29. Shri Rajeev Yadav	L.D.C.

Ancilary Staff

1. Shri Sohan Singh	Driver
2. Shri Shyam Singh	Driver
3. Mrs. Kamla Devi	Bearer
4. Mrs. Deveshawari Rawat	Bearer
5. Shri S.K. Gupta	Bearer
6. Shri Chait Ram	Bearer
7. Mrs. Omwati	Bearer
8. Shri Jeevan Lal	Bearer
9. Shri Surendra Singh	Bearer
10. Shri Preetam	Bearer
11. Shri Ramesh Chand Rana	MTS (Bearer)
12. Shri Dinesh Pd. Saklani	Guest House Attendant cum Cook
13. Shri Mahendra Singh	Chowkidar
14. Shri Rohlu Ram	Chowkidar
15. Shri H.S. Manral	Chowkidar
16. Shri G.D. Sharma	Chowkidar
17. Shri Ashok Kumar	Mali (Retired on 28.02.2015)
18. Shri Satya Narayan	Mali
19. Shri Ramesh	Safaiwala
20. Shri Hari Kishan	Safaiwala

Contractual Staff

1. Shri Neeraj Bhatt	LDC
2. Shri Dhanveer Singh	LDC
3. Shri R.U. Choudhury	Driver
4. Shri Rajesh Yadav	Driver
5. Shri Bhupendra Singh	Driver
6. Shri Manmohan	Driver
7. Shri Vijay Singh	Driver
8. Shri Rudhra Chetri	Bearer
9. Shri Harish Verma	Bearer
10. Shri Laxman S. Bhandari	Chowkidar
11. Shri Pradeep Kumar	Chowkidar
12. Shri Kalidas	Chowkidar
13. Ummed Singh	Chowkidar
14. Shri Sang Bang Kach	Chowkidar

GOVERNING BODY/RESEARCH ADVISORY COMMITTEE/ FINANCE COMMITTEE/BUILDING COMMITTEE MEMBERS

Governing Body
(during 2014-15)

Sl.	Name	Address	Status
1.	Prof. K. Vijay Raghavan Prof. Ashutosh Sharma (Since 09 Jan 2015)	Secretary Dept. of Science & Technology Technology Bhavan, New Mehrauli Road New Delhi - 110016	Chairman
2.	Ms. Anuradha Mitra Shri J.B. Mohapatra	Joint Secretary & Financial Adviser Dept. of Science & Technology Technology Bhavan, New Mehrauli Road New Delhi - 110016	Member
3.	Prof. (Mrs.) Archana Bhattacharyya	Emeritus Scientist Indian Institute of Geomagnetism Kalamboli Highway, New Panvel (W) Navi Mumbai - 410218	Member
4.	Dr. V.P. Dimri	CSIR Distinguished Scientist National Geophysical Research Institute Uppal Road, Hyderabad - 500007	Member
5.	Prof. U.C. Mohanty	Centre for Atmospheric Sciences Indian Institute of Technology, Delhi Hauzkhas, New Delhi - 110016	Member
6.	Prof. M.P. Singh	124, Chand Ganj Extn. (Opposite CM-7) Sector 'B', Aliganj Lucknow (UP)	Member
7.	Prof. Shyam Lal	Physical Research Laboratory Navrangpura Ahmedabad - 380009	Member
8.	Prof. R.P. Tiwari	Department of Geology Mizoram University Aizawl - 796009	Member
9.	Prof. Anil K. Gupta	Director Wadia Institute of Himalayan Geology Dehradun - 248001	Member Secretary
10.	Shri Dinesh Chandra	Registrar Wadia Institute of Himalayan Geology Dehradun - 248001	Non-Member Asstt. Secretary

Research Advisory Committee
(during 2014-15)

Sl.	Name	Address	Status
1.	Prof. S.K. Tandon	Professor Wadia Chair Indian Institute of Technology, Kanpur Kanpur - 208106	Chairman
2.	Dr. S. Sinha Roy	(Ex-Deputy D.G., GSI) Birla Institute of Scientific Research Statue Circle Jaipur-302001	Member
3.	Prof. D.C. Srivastava	Department of Earth Sciences Indian Institute of Technology-Roorkee Roorkee-247667	Member
4.	Prof. M. Jayananda	Centre for Earth and Space Sciences University of Hyderabad Hyderabad-500046	Member
5.	Prof. Kusala Rajendran	Centre for Earth Sciences Indian Institute of Science Bangalore-560012	Member
6.	Dr. R.S. Dattatrayam	Head, Seismology Division India Meteorological Department Lodi Road, New Delhi-110003	Member
7.	Dr. V.M. Tiwari	Scientist National Geophysical Research Institute Uppal Road Hyderabad-500007	Member
8.	Prof. S.J. Sangode	Department of Geology University of Pune Pune-411007	Member
9.	Dr. J.R. Kayal	73-B, Thakur Pukur Road Kolkata-700 063	Member
10.	Prof. M.K. Panigrahi	Department of Geology & Geophysics Indian Institute of Technology-Kharagpur Kharagpur-721 302	Member
11.	Prof. S. Tripathy	Deputy Director & Head School of Earth, Ocean and Climate Sciences Indian Institute of Technology-Bhubaneswar Bhubaneswar-751 007	Member

Sl.	Name	Address	Status
12.	Prof. R.P. Tiwari	Dean School of Engineering & Technology Mizoram University Aizawl-796009 (At present VC, Sagaur University)	Member
13.	Dr. Snehmani	Joint Director Snow and Avalanche Study Establishment Him Parisar, Sector - 37A Chandigarh-160036	Member
14.	Prof. Anil K. Gupta	Director, WIHG Wadia Institute of Himalayan Geology Dehradun-248001	Member
15.	Dr. S.K. Parcha	Scientist `F', WIHG Wadia Institute of Himalayan Geology Dehradun-248001	Member Secretary

Finance Committee
(during 2014-15)

Sl.	Name	Address	Status
1.	Prof. M.P. Singh	124, Chand Ganj Extn. (Opposite CM-7) Sector 'B', Aliganj Lucknow (UP)	Chairman
2.	Ms. Anuradha Mitra Shri J.B. Mohapatra	Additional Secretary & Financial Adviser Dept. of Science & Technology Technology Bhavan, New Mehrauli Road New Delhi - 110016	Member
3.	Prof. Anil K. Gupta	Director Wadia Institute of Himalayan Geology 33, General Mahadeo Singh Road Dehradun - 248001	Member
4.	Shri Dinesh Chandra	Registrar Wadia Institute of Himalayan Geology 33, General Mahadeo Singh Road Dehradun - 248001	Member
5.	Shri Harish Chandra	Finance & Accounts Officer Wadia Institute of Himalayan Geology 33, General Mahadeo Singh Road Dehradun - 248001	Member Secretary

Building Committee
(during 2014-15)

Sl.	Name	Address	Status
1.	Prof. Anil K. Gupta	Director Wadia Institute of Himalayan Geology 33, General Mahadeo Singh Road Dehradun - 248001	Chairman
2.	Ms. Anuradha Mitra Shri J.B. Mohapatra	Additional Secretary & Financial Adviser Dept. of Science & Technology Technology Bhavan, New Mehrauli Road New Delhi - 110016	Member
3.	Shri Harsh Mani Vyas	G.M. (Infrastructure Development) Shed No. 32, Tel Bhawan Oil & Natural Gas Corporation Dehradun - 248001	Member
4.	Representative of Survey of India	Shri D.N. Pathak Superintending Surveyor Surveyor General's Office Survey of India, Hathibarkala, Dehradun - 248001	Member
5.	Dr. Rajesh Sharma	Scientist 'G' Wadia Institute of Himalayan Geology 33, General Mahadeo Singh Road Dehradun - 248001	Member
6.	Shri Dinesh Chandra	Registrar Wadia Institute of Himalayan Geology 33, General Mahadeo Singh Road Dehradun - 248001	Member
7.	Shri C.B. Sharma	Assistant Engineer Wadia Institute of Himalayan Geology 33, General Mahadeo Singh Road Dehradun - 248001	Member Secretary

STATEMENT OF ACCOUNTS

CA Vipul Kumar Singhal
(M.Com, IFRS, F.C.A.)

CA Gaurav Rajput
(M.Com, F.C.A.)

CA Manoj Kumar
(M.Com, F.C.A.)

VIPUL SINGHAL & ASSOCIATES
Chartered Accountants

H.O. : Maharaja Complex, Shop No. 2, Niranjanpur Dehradun (Uttarakhand) - 248001
B.O. : Shop No. 14, Baba Golden Tower, Opp. Thana Kotwali, Distt. Bijnor (Uttar Pradesh) -246701
Web : www.cavsassociates.com
E-mail : cavsassociates@gmail.com

Contact : 0135-2723911, 9412936655, 9634268812

AUDITOR'S REPORT

The Members of Governing Body,
Wadia Institute of Himalayan Geology,
33, GMS Road, Dehradun
Uttarakhand.

We have audited the accompanying Financial Statements of **WADIA INSTITUTE OF HIMALAYAN GEOLOGY, 33, GMS Road, Dehradun** for the year ended March 31st, 2015 which comprises Balance Sheet ,Income and Expenditure Account, Receipt and Payment Account and summary of significant accounting policies.

Society's management is responsible for the preparation of these Financial Statements in accordance with law. This responsibility includes the design, implementation and maintenance of internal control relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with the Standards on Auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with ethical requirements and plan and perform the audit to obtain reasonable assurance about whether the financial statements are free from material misstatement.

An audit involves performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the Society's preparation and fair presentation of the financial statements in order to design audit procedures that are appropriate in the circumstances. An audit also includes evaluating the appropriateness of accounting policies used and the reasonableness of the accounting estimates made by management, as well as evaluating the overall presentation of the financial statements.

We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

AUDITOR'S REPORT

In our opinion and to the best of our information and according to the explanations given to us, the financial statements give the information required by the Act in all material respects and give a true and fair view in conformity with the accounting principles generally accepted in India subject to our comments given in Annexure-"1":

a) in the case of the Balance Sheet, of the state of affairs of the Society as at March 31st, 2015;
b) in the case of the Income and Expenditure Account of the Surplus for the year ended on that date; and
c) in the case of the Receipt and Payment Account, of the cash flows for the year ended on that date.

FOR VIPUL SINGHAL & ASSOCIATES

CHARTERED ACCOUNTANTS

FRN 013108C

CA VIPUL KUMAR SINGHAL
PARTNER

FRN: 013108C
M.NO: 405071

Date: 30th June, 2015
Place: Dehradun

Annexure - 1 to the Main Audit Report

The following observations were noted during the course of audit for the financial year 2014-2015. The same have been discussed with management, comments and explanations of the management thereon have also been obtained.

Sl. No	Comments / Observations by Chartered Accountants	Replies and Action taken by the Institute
1.	The Institute is maintaining accounts on cash basis except interest accrued on investments, which is not in conformity with the generally accepted accounting policies adopted in India and as per the Accounting Standard 1 "Disclosure of Accounting Policies" issued by the Institute of Chartered Accountants of India. The "Uniform Accounting Format" of financial statements for the Central autonomous bodies as has been made compulsory by the Ministry of Finance w.e.f. 01.04.2001, and adopted by the Institute also, recommends accrual method of accounting.	Institute is receiving Grant-in-aid from Govt. of India on the basis of projection of expenditure submitted by the Institute. However, sufficient funds as against the projected amount are not being received. Hence the accounts are maintained on cash basis for the actual transaction during the year reported. Interest on investment out of the fund for GPF / Pension etc. is taken on accrual basis.
2.	During the Financial Year 2014 -15 all the grants related to recurring and non recurring has been routed through Income & Expenditure Account.	Noted.
3.	The Institute has not booked the current liability for the retirement benefit of the employees as per Accounting Standard 15 "Employees Benefits" as issued by the Institute of Chartered Accountants of India.	Since the accounts are maintained on actual requirement and on cash basis, the liability on account of retirement benefits is not being provided.
4.	The Financial Statements of the institute, projects sponsored by the other agencies, Pension Fund and the CPF/GPF are prepared separately and not consolidated as per Accounting Standard 21 "Consolidation of financial Statement" as issued by the Institute of Chartered Accountants of India. The CPF/GPF, Projects sponsored by the other agencies and Pension Fund are also part of the Institute as they do not have a separate legal identity.	Financial statement in respect of consultancy activity have already been consolidated with the financial statement of the Institute and the observation of the auditor has been noted for compliance in future.
5.	The internal control regarding fixed assets needed to be strengthened. The following observations are made : a) The Fixed Asset Register is not maintained by the Institute. b) The additions to fixed assets are not numbered properly. c) The Physical verification of the fixed asset for the Financial Year 2014-15 is due to be undertaken, upto the date of Audit.	The suggestion on the observation of the audit has been noted for compliance. Physical verification of assets for the Financial Year 2014-2015 is in progress and the report will be produced in the next audit.

FRN

AUDITOR'S REPORT

6.	The Institute is adopting the policy of charging depreciation on fixed assets on the basis of written down value method as per the rates specified in the Income Tax Act, 1961, however, the following observations are made: a) Full year depreciation is charged instead of six months, on assets purchased for the half year ending 31st March, 2015. As per the management the same policy had been adopted in the previous financial years also. b) The books are depreciated @ 15% p.a. instead of 60% p.a. on W.D.V basis as applicable to research institutes.	The observations of the auditor have been noted for compliance.
7.	The Institute has not bifurcated the advances indicating the period of outstanding given to staff and Parties. The Party Debtors amounting to Rs. 1,40,921/- and Staff Debtors amounting to Rs 22,832/- are outstanding since more than 4 years. The advance which could not be realized in due course should be written off with the approval of the competent authority. Rs 1,64,143.00 has been shown as credit balance in Party debtors and Rs 37,629/- in Staff Debtor which should be taken to receipts after following nodal procedure.	Institute has made its best efforts to settle the outstanding advances lying against debtors. Most of the outstanding advances against staff debtors have been adjusted. However, some of the advances outstanding against party debtors for a number of years could not be settled. The matter was submitted to the Finance Committee for its consideration and recommendation to write-off the outstanding amount in its meeting held on 31.10.2014. It was advised by the Finance Committee that a detailed proposal may be submitted to Deptt. of Science & Technology for decision and guidance. The progress in the case will be submitted in the next audit.
8.	Earmarked funds have the debit balance in Training Workshop Programme Ladakh of Rs. 2,19,905.00, Annual Convention (IGU 2009) of Rs. 41,275.00, WIHG-IGU Workshop 2013 of Rs. 3,32,048.00 and HKT-2015 Workshop of Rs. 16,854.00. The same depicts that the amount had been expended from other funds specific for other purposes. The loan from WIHG should have been shown when the amount was utilized from other funds and the same should have been shown as current liability in the Institute accounts.	To organize training, workshops, other short term programmes etc., for which funds are provided by other granting agencies, are received occasionally in advance otherwise generally the funds are received after completion of the activities. For successful organization of the proposed activities, the required funds are spent from the Institute grant on refundable basis and generally reimbursement is received only after submission of the utilization certificate etc. Request to all the granting agencies have already been submitted for early release of the funds borrowed from the Institute account.
9.	Issues related to Service Tax: During the course of audit it is observed that the Institute has received advance payment against the services under Consultancy but the entries for Service tax etc. has been accounted for at the time of final adjustment. Further Rs. 14523.00 has been outstanding as Service tax payable which is due to be deposit till the date of Audit.	As per the suggestion of the auditor the service tax is now being accounted with each transaction and the outstanding amount of service tax had already been deposited during the current financial year 2015-16. Now the service tax is being deposited online.

	Further Service tax in respect of UBI rent has not been recovered and deposited.	The matter regarding deposit of service tax by the Union Bank of India on the rent being paid by them had already been taken up with the authorities of the bank. The matter had been referred by the bank to their Head-Quarters. It has been intimated verbally by the Bank Authorities that approval from their Headquarters is likely to be received soon for payment of service tax. The progress in the matter will be reported during the next audit.
11.	Issues related to Tax Deduction at Source : It is observed that the institute has not deducted TDS at the time of making advance payments to contractors.	Permissible advance payment to the contractor against the civil work executed by them was only released. Final payment was released within the same month and due tax deducted at source. Work contract tax etc. was also deducted and deposited to the concerned authorities on the date of payment of running bill to the contractor. However, the observation of the audit has been noted for compliance in future.
12.	Issues related to Tender : WIHG should follow the e- tendering process for tender as per Govt. of India- Procurement rules.	As per the instruction from Govt. of India the e-tendering process for procurement of material etc. is being followed.
13.	Issues related to Bank Reconciliation Statement: During the course of audit it was observed that many entries were found to be outstanding since long in Bank Reconciliation Statement as on 31.03.2015 on UBI A/c no 33001.	Two cheques amounting to Rs. 68,000.00 and 1,000.00 were issued after revalidations and two cheques amounting to Rs. 600.00 and 1,000.00 will be taken back in the Institute account. Amount debited by bank towards L/c opening charges etc. is being accounted for alongwith the value of the Equipment received during the current financial year.
	We are thankful to the staff and the management for the co-operation extended to us during the course of audit. **For Vipul Singhal & Associates** **Chartered Accountants** FRN 013108C **CA Vipul Kumar Singhal** **[Partner, FCA]** Date : 30th June, 2015 Place: Dehradun	**(Harish Chandra)** **(Dinesh Chandra)** **Fin.& Accounts Officer** **Registrar** **(Prof. Anil K. Gupta)** **Director**

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY- DEHRADUN

CONTENTS

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRADUN

BALANCE SHEET
(AS AT 31ST MARCH 2015)

(Amt in Rs...)

PARTICULARS	SCHEDULE	CURRENT YEAR	PREVIOUS YEAR
LIABILITIES			
Corpus/ Capital Fund	1	490,062,737	463,831,020
Reserves and Surplus	2	-	-
Earmaked/ Endowment Fund	3	1,305,537	1,091,661
Secured Loans & Borrowings	4	-	-
Unsecured Loans & Borrowings	5	-	-
Deferred Credit Liabilities	6	-	-
Current Liabilities & Provisions	7	7,580,683	7,281,882
TOTAL		**498,948,957**	**472,204,563**
ASSETS			
Fixed Assets	8	350,266,717	317,817,013
Investments from Earmaked/ Endowment Funds	9	39,930	36,889
Investment- Others	10	-	-
Current Assets, Loans & Advances	11	148,642,310	154,350,661
TOTAL		**498,948,957**	**472,204,563**
Significant Accounting Policies	37		
Contingent Liabilities and Notes on Accounts	38		

AUDITOR'S REPORT
"As per our separate report of even date"

FOR VIPUL SINGHAL & ASSOCIATES
CHARTERED ACCOUNTANTS

(CA VIPUL KUMAR SINGHAL)
PARTNER, F.C.A

(HARISH CHANDRA) Finance & Accounts Officer

(DINESH CHANDRA) Registrar

(PROF. ANIL K. GUPTA) Director

Date : 30th June, 2015
Place : Dehradun

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 2015

SCHEDULE 1 : CORPUS/CAPITAL FUND

(Amt in Rs…)

PARTICULARS	SCH	RECURRING FUND	NON-RECURRING FUND	CURRENT YEAR	PREVIOUS YEAR
Opening Balance		**31,142,242**	**432,688,778**	**463,831,020**	**391,375,619**
Add: Contribution towards Corpus / Capital Fund	13	-	-	-	-
Add: Transferred from WIHG Project		-	-	-	394,998
Add: Surplus/(Deficits) as per Income & Expenditure A/c		26,231,717	-	**26,231,717**	72,060,403
BALANCE AS AT YEAR END		**57,373,959**	**432,688,778**	**490,062,737**	**463,831,020**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF. ANIL K. GUPTA)
Director

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRADUN

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 2015

SCHEDULE 2 : RESERVE & SURPLUS

(Amt in Rs…)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1 **Capital Reserve :**		
As per last account	-	-
Addition during the year	-	-
Less: Deduction during the year	-	-
2 **Revaluation Reserve :**		
As per last account	-	-
Addition during the year	-	-
Less: Deduction during the year	-	-
3 **Special Reserve :**		
As per last account	-	-
Addition during the year	-	-
Less: Deduction during the year	-	-
4 **General Reserve :**		
As per last account	-	-
Addition during the year	-	-
Less: Deduction during the year	-	-
TOTAL	-	-

(HARISH CHANDRA) Finance & Accounts Officer

(DINESH CHANDRA) Registrar

(PROF. ANIL K. GUPTA) Director

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 2015

SCHEDULE 3 : EAR MARKED / ENDOWMENT FUND

(Amt in Rs.)

PARTICULARS	FUND WISE BREAK UP						TOTAL	
	TRAINING WORKSHOP PROG. LADDAKH	PR.MISHRA AWARD FUND	WOMEN COMPONENT	ANNUAL CONVENTION (I.G.U 2009)	RTF DCS FELLOWSHIP	WIHG - IGU WORKSHOP - 2013	CURRENT YEAR	PREVIOUS YEAR
a) Opening Balance of the Fund	(219,905)	36,889	500,000	(41,275)	14,333	(332,048)	(42,006)	542,837
b) Additions to the fund								
i) Donation / Grant	-	200,000	-	-	-	-	200,000	140,000
ii) Income from investments made on account of fund	-	3,041	-	-	-	-	3,041	2,872
iii) Other additions (Specify)								
Registration	-	-	-	-	-	-	-	12,000
TOTAL	(219,905)	239,930	500,000	(41,275)	14,333	(332,048)	161,035	697,709
c) Utilisation / Expenditure towards objectives of Fund								
i) Capital Expenditure								
- Fixed Assets (Equipments)	-	-	-	-	-	-	-	-
ii) Revenue Expenditure								
a) Salaries / Wages/ Allowances/honorarium	-	-	-	-	-	-	-	265,667
b) Rent / Contingencies/TA-DA/Advertisement	-	-	-	-	-	-	-	427,090
c) Other Administrative Expenses								
- Advances to project fellows	-	-	-	-	-	-	-	-
d) Excess fund Transferred	-	-	-	-	-	-	-	-
e) lodging and boarding	-	-	-	-	-	-	-	46,958
f) Registration	-	-	-	-	-	-	-	-
iii) Grant refunded	-	-	-	-	14,333	-	14,333	-
iv)Transfer To WIHG	-	-	-	-	-	-	-	-
TOTAL	-	-	-	-	14,333	-	14,333	739,715
Balance Carried Forward	(219,905)	239,930	500,000	(41,275)	0	(332,048)	146,702	(42,006)

Contd.2

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN
SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 2015

SCHEDULE 3 : EAR MARKED / ENDOWMENT FUND

(Amt in Rs....)

PARTICULARS	TSUNAMI EQUIPMENT	PMB MEETING 2009	HKT-2015 WORKSHOP	INDO-NORWEGIAN MEET	MMND WORKSHOP (DR. V. C. TIWARI)	BRAIN STORMING MEETING (DR. P. Srivastav)	TOTAL CURRENT YEAR	TOTAL PREVIOUS YEAR
Balance Brought forward							146,702	(42,006)
a) **Opening Balance of the Fund**	830,633	42,255	-	-	(167,774)	43,533	748,647	615,087
b) **Additions to the fund**								
i) Donation / Grant	-	-	-	200,000	167,774	-	367,774	507,881
ii) Income from investments made on account of fund	-	-	-	-	-	-	-	-
iii) Other additions (Specify)	-	-	-	-	-	-	-	-
Registration	-	-	-	-	-	-	-	-
Advance Adjusted	-	-	-	-	-	-	-	100,000
TOTAL	830,633	42,255	-	200,000	-	43,533	1,116,421	1,222,888
c) **Utilisation / Expenditure towards Objectives of Fund**								
i) Capital Expenditure								
- Fixed Assets (Equipments)	-	-	-	-	-	-	-	-
ii) Revenue Expenditure					-	-	-	254,766
a) Salaries / Wages/ Allowances	-	-	-	-	-	-	-	-
b) Rent / Contingencies/TA-DA	-	-	-	151,553.00	-		151,553	-
c) Other Administrative Expenses	-	-	-	-	-	-	-	-
- Advances to project fellows	-	-	16,854	-	-	-	16,854	219,475
d) Excess fund Transferred	-	-	-	-	-	-	-	-
e) Lodging & boarding	-	-	-	-	-	-	-	-
iii) Grant refunded/transferred	-	-	-	-	-	43,533	43,533	-
iv)Transfer To WIHG	-	-	-	-	-	-	-	-
TOTAL	-	-	16,854	151,553	-	43,533	211,940	474,241
Balance	830,633	42,255	(16,854)	48,447	-	-	904,481	748,647
GRAND TOTAL							1,051,183	706,641

Contd.3

SCHEDULE 3 : EAR MARKED / ENDOWMENT FUND

(Amt in Rs. .)

PARTICULARS	GEOMATHEMATIC WINTER SCHOOL TRAINING	BRAIN STORMING MEETING (MOES - DR. P. Srivastav)	INSPIRE FELLOWSHIP (BL Mishra)	TOTAL CURRENT YEAR	TOTAL PREVIOUS YEAR
Balance Brought forward				1,051,183	706,641
a) Opening Balance of the Fund	(34,980)	400,000	20,000	385,020	
b) Additions to the fund					
I) Donation / Grant	34,980	-	250,400	285,380	1,200,400
ii) Income from investments made on account of fund	-	-	-	-	-
iii) Other additions (Specify)	-	-	-	-	-
Registration	-	-	-	-	
TOTAL	-	400,000	270,400	670,400	1,200,400
c) Utilisation / Expenditure towards					
Objectives of Fund					
I) Capital Expenditure					
- Fixed Assets (Equipments)	-	-	-	-	-
ii) Revenue Expenditure					
a) Salaries / Wages/ Allowances	-	-	211,200	211,200	230,400
b) Rent / Contingencies/TA-DA	-	184,846	20,000	204,846	350,080
c) Other Administrative Expenses	-		-	-	-
- Advances to project fellows	-	-	-	-	-
d) Excess fund Transferred	-	-	-	-	-
e) Lodging & boarding	-	-	-	-	234,900
					-
iii) Grant refunded/transferred	-	-	-	-	-
iv)Transfer To WIHG	-	-	-	-	-
TOTAL	-	184,846	231,200	416,046	815,380
Balance	-	215,154	39,200	254,354	385,020
GRAND TOTAL				1,305,537	1,091,661

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF. ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 2015

SCHEDULE 4 : SECURED LOAN & BORROWINGS

(Amt in Rs…)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Central Government	-	-
2	State Government	-	-
3	Financial Institution		
	a) Term Loans	-	-
	b) Interest accrued and due	-	-
4	Banks		
	a) Term Loan		
	- Interest accrued and due	-	-
	b) Others Loans (Specify)		
	- Interest accrued and due	-	-
5	Other Institution & Agencies	-	-
6	Debenture and Bonds	-	-
7	Others (Specify)	-	-
	TOTAL	-	-

(HARISH CHANDRA)	(DINESH CHANDRA)	(PROF. ANIL K. GUPTA)
Finance & Account Officer	Registrar	Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 2015

SCHEDULE 5 : UNSECURED LOANS & BORROWINGS

(Amt in Rs…)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Central Government	-	-
2	State Government (Specify)	-	-
3	Financial Institution	-	-
4	Banks		
	a) Term Loans	-	-
	b) Others Loans (Specify)	-	-
5	Other Institution & Agencies	-	-
6	Debenture and Bonds	-	-
7	Fixed Deposits	-	-
8	Others (Specify)	-	-
	TOTAL	-	-

SCHEDULE 6 : DEFERRED CREDIT LIABILITIES

(Amt in Rs…)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
a.	Acceptance secured by hypothecation of capital equipments and other assets	-	-
b.	Others	-	-
	TOTAL	-	-

(HARISH CHANDRA)
Finance & Accounts officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 2015

SCHEDULE 7 : CURRENT LIABILITIES & PROVISIONS

(Amt in Rs...)

		PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
A.		**Current Liabilities**		
	1	Acceptance	-	-
	2	Sundry Creditors		
		a) For goods	-	-
		b) Staff/Others (As per Annexure '1')	1,384,875	376,447
	3	Securities from Suppliers (As per Annexure '17')	2,826,826	3,405,783
	4	Interest accrued but not due on		
		a) Secured Loans/ Borrowings	-	-
		b) Unsecured Loans/ Borrowings	-	-
	5	Statutory Liabilities		
		a) TDS Payable	-	-
		b) GPF/CPF	-	-
		c) NPS Subscription	-	-
		d) Uttaranchal Trade Tax	-	-
	6	Other Current Liabilities		
		Group Insurance	3,129	3,375
		Consultancy Activity	3,249,061	3,478,582
		PLI	120	120
		Expenses payable (As per Annexure '16')	116,672	17,575
		TOTAL (A)	**7,580,683**	**7,281,882**
B.		**Provisions**		
	1	For Taxation	-	-
	2	Gratuity	-	-
	3	Superannuation/ Pension	-	-
	4	Accumulated Leave Encashment	-	-
	5	Trade Warranties Claims	-	-
	6	Other Specify	-	-
		TOTAL (B)	-	-
		TOTAL (A + B)	**7,580,683**	**7,281,882**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 2015

SCHEDULE 8 : FIXED ASSETS

(Amt in Rs.)

PARTICULARS	GROSS BLOCK				DEPRECIATION					NET BLOCK		
	COST AS ON BEGINING OF THE YEAR	ADDITION DURING THE YEAR	DED./WRITT. OFF / TRFD. DURING THE YR.	COST AT THE END OF THE YEAR	OPENING BALANCE	OPENING BAL. TFD FROM PROJECT	DEP DURING THE YEAR	DED./WRITT. OFF / TRFD DURING THE YR.	TOTAL	CURRENT YEAR	PREVIOUS YEAR	RATE OF DEP.
Fixed Assets												
1 **Land**												
a) Freehold	826,780	-		826,780	-	-	-	-	-	826,780	826,780	
b) Leasehold	-			-	-				-	-	-	
					-				-	-	-	
2 **Building**					-				-	-	-	
a) On Freehold Land (Main Building)	12,743,996	-		12,743,996	7,806,711		493,729		8,300,440	4,443,556	4,937,285	10%
b) On Leasehold Land	-			-	-		-		-	-	-	10%
c) Guest House cum Hostel/ Staff Quarter	10,093,765	-		10,093,765	6,173,263		392,050		6,565,313	3,528,452	3,920,502	10%
d) Store Building	9,615,648	-		9,615,648	5,473,992		414,166		5,888,158	3,727,490	4,141,656	10%
e) New Lab Complex(IVth Block)	8,511,316	-		8,511,316	5,213,858		329,746		5,543,604	2,967,712	3,297,458	10%
f) Boundary wall (Dharamshala)	641,905	-		641,905	377,517		26,439		403,956	237,949	264,388	10%
g) Staff Quarters Type III & IV - Phase I	11,848,397	-		11,848,397	5,551,673		629,672		6,181,345	5,667,052	6,296,724	10%
h) Staff Quarters Type III & IV - Phase II	18,231,591			18,231,591	4,940,761		1,329,083		6,269,844	11,961,747	13,290,830	10%
i) Mass Renovation of WIHG Building	30,788,561	7,086,833	-	37,875,394	5,507,468		3,236,793		8,744,261	29,131,133	25,281,093	10%
j) Bank Building	1,796,289	-		1,796,289	841,668		95,462		937,130	859,159	954,621	10%
k) Road & Cabling	613,781	-		613,781	287,592		32,619		320,211	293,570	326,189	10%
l) Directors Residence	6,487,581			6,487,581	1,758,134		472,945		2,231,079	4,256,502	4,729,447	10%
	-			-	-				-			
3 **Plant, Machinery & Equipment**	414,207,104	66,011,736	-	480,218,840	247,728,628		34,879,532	-	282,608,160	197,610,680	166,478,476	15%
					-				-			
4 **Vehicles**	3,182,349	-	-	3,182,349	1,603,904		236,767		1,840,671	1,341,678	1,578,445	15%
					-				-			
5 **Furniture & Fixtures**	11,082,342	174,441	-	11,256,783	5,774,188		548,260	-	6,322,448	4,934,335	5,308,154	10%
6 **Office Equipments**	5,543,842	1,096,920	-	6,640,762	1,160,321		822,066	-	1,982,387	4,658,375	2,383,521	15%
					-				-			
7 **Field Equipments- WIHG**	1,315,631	-	-	1,315,631	788,928		79,005	-	867,933	447,698	526,703	15%
- Consultancy Activity	18,044	-		18,044	13,865		627		14,492	3,552	4,179	15%
8 **Library Books**												
a) Books & Charts	116,389,959	11,758,311	480	128,147,790	67,387,301		9,114,129	369	76,501,061	51,646,729	49,002,658	15%
9 **Tube Well & Water Supplies**	208,974	-		208,974	160,572		7,260		167,832	41,142	48,402	15%
10 **Computer & printers**	5,820,889	1,086,854	-	6,907,743	4,804,643	-	1,261,860		6,066,503	841,240	1,016,246	60%
Building under Construction -WIP	-	1,077,419	-	1,077,419	-	-	-	-	-	1,077,419	-	
	667,968,744	99,332,514	480	758,300,778	373,354,987	-	54,402,210	369	427,756,828	330,543,950	294,613,757	
Equipments (Project)												
(As per Annexure '10')	88,971,192	-		88,971,192	65,767,936	-	3,480,489		69,248,425	19,722,767	23,203,256	15%
TOTAL OF CURRENT YEAR	756,939,936	99,332,514	480	847,271,970	439,122,923	-	57,882,699	369	497,005,253	350,266,717	317,817,013	
TOTAL OF PREVIOUS YEAR	752,833,645	22,718,843	18,612,552	756,939,936	399,360,441	1,805,133	52,710,881	13,973,232	439,122,923	317,817,013	353,473,302	

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 2015

SCHEDULE 9 : INVESTMENT FROM EARMARKED/ ENDOWMENT FUND

(Amt in Rs…)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	In Government Securities	-	-
2	Other Approved Securities	-	-
3	Shares	-	-
4	Debentures and Bonds	-	-
5	Subsidaries and Joint ventures	-	-
6	Others		
	a) Fixed deposit of Prof. Mishra Award Fund	39,930	36,889
	TOTAL	39,930	36,889

SCHEDULE 10 : OTHER INVESTMENT

(Amt in Rs…)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	In Govt. Securities	-	-
2	Other Approved Securities	-	-
3	Shares	-	-
4	Debentures and Bonds	-	-
5	Subsridaries and Joint ventures	-	-
6	Others	-	-
	TOTAL	-	-

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF. ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST MARCH 2015

SCHEDULE 11 : CURRENT ASSETS, LOANS & ADVANCES

(Amt in Rs…)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
CURRENT ASSETS (A)		
Inventories		
a) Publications (Himalayan Geology Volumes)		
(As per Annexure '2')	379,097	416,149
Sundry Debtors (As per Annexure '3')	3,520,169	317,742
Cash Balance in Hand	4,892	42,219
Imprest Money - WIHG (As per Annexure '4')	-	52,000
Bank Balance		
a) With Scheduled Bank		
- On Saving Account(UBI S/A No. 518602170033001)	29,621,309	22,403,544
- On Saving Account(SBI) A/c No. 10022411762	28,578	27,283
- On Deposit Account (L/C Margin Money)	67,927,350	89,700,000
b) With Non- Scheduled Bank		
- On Current Account	-	-
- On Deposit Account (Includes Margin Money)	-	-
- On Saving Account (Projects)	-	-
Consultancy Activity		
Cash at Bank A/c No 563	8,788,989	7,074,358
FDR	32,072,946	29,625,995
Cash at Bank of E-Payment A/c :		
Saving A/c UBI 518602010006986	9,906	-
Post Office Saving Accounts	-	-
TDS	1,076,384	1,035,934
TOTAL (A)	**143,429,620**	**150,695,224**

Continue…

SCHEDULE 11 : CURRENT ASSETS, LOANS & ADVANCES

(Amt in Rs...)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
LOANS & ADVANCES (B)		
Loans		
a) Staff (As per Annexure '5')	2,289,169	2,509,718
Advances & Other amount recoverable in cash or in kind or for value to be received		
a) On Capital Account	-	-
b) GPF / CPF	-	-
c) Others		-
Income Accrued		
a) On Investments from earmarked/endowment fund	-	-
b) On other Investments	1,906,149	251,325
c) On Loans & Advances	-	-
d) Others (Including Projects/ Cheques/ Drafts & Imprests)	-	-
Claims Receivable - Consultancy Activity		
Consultancy Receivable	-	2,022
E-Payment A/c	-	-
Security Deposit (As per Annexure '12')	1,017,372	892,372
TOTAL (B)	**5,212,690**	**3,655,437**
TOTAL (A + B)	**148,642,310**	**154,350,661**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRADUN

INCOME & EXPENDITURE ACCOUNT
FOR THE PERIOD ENDED 31ST MARCH 2015

(Amt in Rs...)

S.NO.	PARTICULARS	SCH.	CURRENT YEAR	PREVIOUS YEAR
A	**INCOME**			
	Income from sales/ services	12	-	-
	Grants/ Subsidies	13	287,533,000	329,250,000
	Fees/Subscription	14	19,000	51,000
	Income from Investments	15	953,779	666,704
	Income from Royalty, Publication etc.	16	45,950	39,664
	Interest earned	17	12,281,043	5,744,910
	Other Income	18	6,056,445	6,473,809
	Increase/ Decrease in Stock (Goods & WIP)	19	-	-
	TOTAL (A)		**306,889,217**	**342,226,087**
B	**EXPENDITURE**			
	Establishment Expenses	20	180,152,679	178,128,463
	Other Research & Administrative Expenses	21	42,578,815	35,942,465
	Expenditure on Grant/ Subsidies etc.	22	-	-
	Interest/ Bank Charges	23	6,624	8,576
	Depreciation Account	8	57,882,699	52,710,591
	Increase/ Decrease in stock of Finished goods, WIP& Stock of Publication	A-2	37,052	72,553
	Loss / (Profit) on sale of Assets	A-19	(369)	3,303,036
	TOTAL (B)		**280,657,500**	**270,165,684**
	Surplus/ (Deficit) being excess of Income over Expenditure (A - B)		26,231,717	72,060,403
	Transfer to Special Reserve (Specify each)		-	-
	Transfer to / from General Reserve		-	-
	BALANCE BEING SURPLUS /(DEFICIT) CARRIED TO CORPUS FUND		**26,231,717**	**72,060,403**

AUDITOR'S REPORT
"As per our separate report of even date"

FOR VIPUL SINGHAL & ASSSOCIATES
CHARTERED ACCOUNTANTS

FRN 013102C

(CA VIPUL KUMAR SINGHAL)
PARTNER, FCA

(HARISH CHANDRA)	**(DINESH CHANDRA)**	**(PROF ANIL K. GUPTA)**
Finance & Accounts Officer	Registrar	Director

Date : 30th June, 2015
Place: Dehradun

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULES FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING ON 31ST MARCH 2015

SCHEDULE 12 : INCOME FROM SALE / SERVICES

(Amt in Rs.)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1 Income From Sales :		
a) Sale of Finished Goods	-	-
b) Sale of Raw Material	-	-
c) Sale of Vehicle		-
2 Income From Services :		
a) Labour & Processing Charges	-	-
b) Professional/Consultancy Service	-	-
c) Agency Commission & Brokerage	-	-
d) Maintenance Service (Equipment/ Property)	-	-
e) Others (Specify)	-	-
TOTAL	-	-

SCHEDULE 13 : GRANT & SUBSIDIES

(Amt in Rs.)

ARTICULARS	PLAN Non Recurring	PLAN Recurring	NON PLAN	CURRENT YEAR	PREVIOUS YEAR
1 Central Government	82,533,000	201,085,000	3,915,000	287,533,000	329,250,000
2 State Government	-	-	-	-	-
3 Government Agencies	-	-	-	-	-
4 Institutions / Welfare Bodies	-	-	-	-	-
5 International Organisation	-	-	-	-	-
6 Others (Specify)	-	-	-	-	-
TOTAL	**82,533,000**	**201,085,000**	**3,915,000**	**287,533,000**	**329,250,000**

(HARISH CHANDRA)	**(DINESH CHANDRA)**	**(PROF ANIL K. GUPTA)**
Finance & Accounts Officer	Registrar	Director

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULES FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING ON 31ST MARCH 2015

SCHEDULE 14 : FEES/ SUBSCRIPTION

(Amt in Rs.)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	**Entrance Fees**	-	-
2	**Annual Fees/ Subsription**	19,000	51,000
	(WIHG Lib.)	-	-
3	**Seminar/ Programme Fees**	-	-
4	**Others(Specify)**	-	-
	TOTAL	**19,000**	**51,000**

SCHEDULE 15 : INCOME FROM INVESTMENT

(Amt in Rs.)

		PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
		(Income on Investment from Earmarked/ Endowment fund transferred to fund)		
1		**Interest**		
	a)	On Government Securities		-
	b)	Other Bonds/ Debenture	-	-
2		**Dividend**	-	-
	a)	On Shares	-	-
	b)	On Mutual Funds Securities	-	-
3		**Rent**	953,779	666,704
4		**Others (Specify)**	-	-
		TOTAL	**953,779**	**666,704**

SCHEDULE: 16 INCOME FROM ROYALTY, PUBLICATION ETC.

(Amt in Rs.)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	**Income from Royalty**	-	-
2	**Income From Publication**	45,950	39,664
	(WIHG Volumes)	-	-
3	**Others (Specify)**	-	-
4	**Gratis to Life Members**	-	-
	TOTAL	**45,950**	**39,664**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF. ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULES FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING ON 31ST MARCH 2015

SCHEDULE: 17 INTEREST EARNED

(Amt in Rs...)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	**In Term Deposit :**		
	a) With Scheduled Bank	4,894,932	309,975
	b) With Non-Scheduled Bank	-	-
	c) With Institution	-	-
	d) Others	-	-
2	**On Saving Account :**		
	a) With Scheduled Bank	3,427,995	2,139,464
	b) With Non-Scheduled Bank	-	-
	c) Post Office Saving Account	-	-
	d) E-Payment a/c	156	-
3	**On Loans :**		
	a) Employees/ Staff :		
	-HBA	707,206	492,694
	-Conveyance Advance	73,665	61,401
	-Computer Advance	96,972	52,221
	b) -Others	-	-
4	**Interest on Debtor & Other Receivables :**		
5	**Interest - Consultancy Activity**	3,080,117	2,689,155
	TOTAL	**12,281,043**	**5,744,910**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULES FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING ON 31ST MARCH 2015

SCHEDULE 18 : OTHER INCOME

(Amt in Rs...)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	**Overhead Charges**	986,955	896,000
2	**Fees for Miscellaneous Services** (As per Annexure'13')	687,727	567,000
3	**Miscellaneous Income** (As per Annexure '14')	4,369,493	4,674,595
4	**Leave Salary & Pension Contribution**	-	283,154
5	**Tender Form Fee**	12,270	53,060
6	**Others (Liquidated Damage)**	-	-
	GRAND TOTAL	**6,056,445**	**6,473,809**

SCHEDULE 19 : INCREASE/ DECREASE IN STOCK OF FINISHED GOODS & WORK IN PROGRESS

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
A. CLOSING STOCK		
- Finished Goods	-	-
- Work in Progress	-	-
B. LESS: OPENING STOCK		
- Finished Goods	-	-
- Work in Progress	-	-
NET INCREASE (DECREASE) (A-B)		-

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULES FORMING PART OF INCOME & EXPENDITURE ACCOUNT
FOR THE YEAR ENDING ON 31ST MARCH 2015

SCHEDULE-20 ESTABLISHMENT EXPENSES

(Amt in Rs.)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
A.	Salary , Wages & Fellowship	52,057,726	53,600,189
	Visiting/research fellowship	4,816,480	4,747,103
B.	Allowances, Bonus & Honorarium		
	1. Allowances	68,138,389	59,810,623
	2. Bonus	343,573	374,668
	3. Honorarium	305,000	376,000
C.	Contribution to CPF	144,385	209,710
D.	Contribution to NPS	1,999,101	1,547,196
E.	Staff Welfare Expenses	-	-
F.	1.Expenses on Employees	-	-
	2.Retirement & Terminal Benefits	21,805,943	25,974,255
	3.TA on Retirement	67,598	119,627
G.	1.Leave Travel Concession	2,327,585	3,290,603
	2.Leave encashment on LTC	1,179,155	1,054,343
H.	Leave Salary & Pension Contribution	22,919,848	22,496,431
I.	1.Others (Medical Reimbursement)	4,047,896	4,402,985
	2.(Training Programme)- In India	-	124,730
	3.(Training Programme)- Abroad	-	-
	TOTAL	180,152,679	178,128,463

(HARISH CHANDRA)
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(DINESH CHANDRA)
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(PROF ANIL K. GUPTA)
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WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULES FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING ON 31ST MARCH 2015

SCHEDULE 21 : OTHER RESEARCH & ADMINISTRATIVE EXPENSES

(Amt in Rs...)

		PLAN	NON PLAN	CURRENT YEAR	PREVIOUS YEAR
a.	Purchases			-	-
b.	Analytical & Dating charges	797,533		797,533	135,572
c.	Cartage & Carriage Inward			-	-
d.	Electricity, Power & Water Charges	4,388,295		4,388,295	4,220,022
e.	Insurance for Vehicle	92,968		92,968	95,818
f.	Repair & Maintenance				
	1. Building & Garden	9,495,355		9,495,355	2,860,484
	2. Equipment & Others	1,409,775		1,409,775	1,795,779
g.	Excise Duty			-	-
h.	Rent, Taxes,Rate Contract & Service Charges	9,160,725	56,000	9,216,725	7,006,295
i.	Vehicle Running & Maintenance	783,983		783,983	738,178
j.	Postage, Telephone		961,220	961,220	978,272
k.	Subscription exps., Internet & bandwidth Charges	171,212		171,212	521,279
l.	Printing & Stationery		700,711	700,711	452,343
m.	Travelling & Conveyance exp. / Field tour expedition	3,298,499	745,178	4,043,677	3,595,898
n.	Exps. On Seminar/Workshop ("As per Annexure 15")	607,689		607,689	3,193,694
o.	Guest House Expense	247,116		247,116	133,044
p.	TA/DA to GB/Committee members	1,477,497		1,477,497	1,007,364
q.	Auditor's Remuneration		28,652	28,652	28,652
r.	Hospitality Exps.		27,718	27,718	37,889
s.	Professional Charges/Legal Exps.	400,125		400,125	268,315
t.	Provision for Bad & Doubtful Debts/ Advances			-	-
u.	Capital/Fixed Assets written off/Loss			-	-
v.	Festival, Fair & Exhibition		569,645	569,645	477,469
w.	Freight & Forwarding Exps.			-	-
x.	Distribution Exps.			-	-
y.	Advertisement & Publicity	228,518	721,042	949,560	659,079
z.	Leveries			-	-
a(i)	Others (Specify)			-	-
	1. Foundation Day		98,475	98,475	67,777
	2. Contingency	709,509		709,509	740,459
	3. Chemical Glassware & Photo Goods	1,180,021		1,180,021	570,627
	4. Royalty			-	126
	5. Publication	65,261		65,261	113,590
	6. Certification Charges for ISO 9001 : 2008			-	157,304
	7.Computer Stationery/Peripherals	1,362,748		1,362,748	3,798,235
	8.Reprints & Research paper			-	5,500
	9.NSDL Service A/C	11,103		11,103	
	10. Renovation, modification & oiling			-	-
	11. Insurance of Field Party	66,961		66,961	67,129
	12. Membership of Scientific Journals	6,000		6,000	96,558
	13. Consultancy Activity Expenses	2,709,281		2,709,281	2,119,714
	TOTAL	**38,670,174**	**3,908,641**	**42,578,815**	**35,942,465**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULES FORMING PART OF INCOME & EXPENDITURE ACCOUNT

FOR THE YEAR ENDING ON 31ST MARCH 2015

SCHEDULE 22 : EXPENDITURE ON GRANT/ SUBSIDIES ETC.

(Amt in Rs…)

	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
a)	Grant given to Institution/Organisations	-	-
b)	Subsidies given to Institutions/Organisation	-	-
	TOTAL	-	-

SCHEDULE 23: INTEREST/CHARGES

(Amt in Rs…)

		PLAN	NON PLAN	CURRENT YEAR	PREVIOUS YEAR
a.	**On Fixed Loan**	-	-	-	-
b.	**On Other Loan**	-	-	-	-
c.	**Bank Charges**	-	6,374	6,374	8,576
d.	**Bank Charges of E-Payment A/c**	250	-	250	-
	TOTAL	250	6,374	6,624	8,576

(HARISH CHANDRA)	(DINESH CHANDRA)	(PROF ANIL K. GUPTA)
Finance & Accounts Officer	Registrar	Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

RECEIPTS & PAYMENTS ACCOUNT
(FOR THE YEAR ENDED 31st MARCH 2015)

(Amt in Rs...)

PARTICULARS	SCH.	CURRENT YEAR	PREVIOUS YEAR
RECEIPTS			
Opening Balance	24	59,225,399	37,962,002
Grants - in - Aids	26	287,533,000	329,250,000
Grants - in - Aids/Other Receipts (Ear Marked)	27	906,195	1,885,674
Loan & Advances	28	82,139,237	113,251,607
Loan & Advances (Ear Marked)	31	40,000	566,500
Fees/Subscription	14	19,000	51,000
Income from Investments	15	953,779	666,704
Income from Royalty, Publication etc.	16	45,950	39,664
Interest earned	17	12,281,043	5,744,910
Other Income	18	6,056,445	6,473,809
Investment (L/C Margin Money)	34	89,700,000	1,145,000
		538,900,048	497,036,870
PAYMENTS			
Establishment Expenses	20	180,152,679	178,128,463
Other Administrative Expenses	21	42,578,815	35,942,465
Expenditure on Grant/Subsidies Etc.	22	-	-
Interest/ Bank Charges	23	6,624	8,576
Loans & Advances	29	86,640,566	113,103,300
Loans & Advances (Ear Marked)	32	43,041	466,500
Investment (L/C Margin Money)	35	67,927,350	88,145,000
Fixed Assets	36	90,332,034	19,962,438
Ear Marked Fund Expenses	33	634,453	2,054,729
Grant - in - Aid (Ear Marked) Refunded	30	57,866	-
Closing Balance	25	70,526,620	59,225,399
		538,900,048	497,036,870

AUDITOR'S REPORT
"As per our separate report of even date"

FOR VIPUL SINGHAL & ASSOCIATES
CHARTERED ACCOUNTANTS

(CA VIPUL KUMAR SINGHAL)
PARTNER, FCA

(HARISH CHANDRA) Finance & Accounts Officer

(DINESH CHANDRA) Registrar

(PROF. ANIL K. GUPTA) Director

Date : 30th June, 2015
Place: Dehradun

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF RECEIPT & PAYMENT AS ON 31ST MARCH 2015

SCHEDULE - 24 : OPENING BALANCE

(Amount in Rs...)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Cash in Hand	42,219	5,347
Cash at Bank : Saving A/c UBI 518602170033001	22,403,544	8,010,033
Saving A/c SBI 10022411762	27,283	45,450
Imprest Money	52,000	58,500
Consultancy Activity		
Cash at Bank A/c No 563	7,074,358	2,395,418
FDR	29,625,995	27,447,254
TOTAL	**59,225,399**	**37,962,002**

SCHEDULE - 25 : CLOSING BALANCE

(Amt in Rs...)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Cash in Hand	4,892	42,219
Cash at Bank : Saving A/c UBI 518602170033001	29,621,309	22,403,544
Saving A/c SBI 10022411762	28,578	27,283
Cash at Bank of E-Payment A/c :		
Saving A/c UBI 518602010006986	9,906	
Imprest Money	-	52,000
Consultancy Activity		
Cash at Bank A/c No 563	8,788,989	7,074,358
FDR	32,072,946	29,625,995
TOTAL	**70,526,620**	**59,225,399**

(HARISH CHANDRA)	(DINESH CHANDRA)	(PROF ANIL K. GUPTA)
Finance & Accounts Officer	Registrar	Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF RECEIPT & PAYMENT AS ON 31ST MARCH 2015

SCHEDULE : 26 GRANT IN AID RELEASED BY DST FOR THE YEAR 2014-15

(Amt in Rs...)

S.NO	SANCTION NO. CURRENT YEAR	DATED	PLAN	NON-PLAN
1	AI/WIHG/NP/003/2014/1	05.05.2014	-	1,450,000
2	AI/WIHG/NP/003/2014/2	01.09.2014	-	1,740,000
3	AI/WIHG/NP/003/2014/3	17.02.2015	-	725,000
4	AI/WIHG/SAL/003/2014/1	24.04.2014	41,500,000	-
5	AI/WIHG/SAL/003/2014/2	25.08.2014	69,000,000	-
6	AI/WIHG/SAL/003/2014/3	21.01.2015	25,025,000	-
7	AI/WIHG/SC/003/2014/1	05.05.2014	3,433,000	-
8	AI/WIHG/SC/003/2014/2	01.09.2014	6,725,000	-
9	AI/WIHG/SC/003/2014/3	21.01.2015	3,292,000	-
10	AI/WIHG/GEN/003/2014/1	05.05.2014	21,150,000	-
11	AI/WIHG/GEN/003/2014/2	01.09.2014	26,960,000	-
12	AI/WIHG/GEN/003/2014/3	21.01.2015	4,000,000	-
13	AI/WIHG/CAP/003/2014/1	05.05.2014	34,133,000	-
14	AI/WIHG/CAP/003/2014/2	01.09.2014	48,400,000	-
	TOTAL		**283,618,000**	**3,915,000**
	GRAND TOTAL			**287,533,000**
	PREVIOUS YEAR			**329,250,000**

SCHEDULE : 27 GRANT - IN - AID/OTHER RECEIPTS (EAR MARKED) AS ON 31ST MARCH 2015

(Amt in Rs...)

S.NO	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Prof Misra Award Fund	203,041	-
2	WIHG - IGU WORKSHOP - 2013	-	112,000
3	Brain Storming Meeting (DR. PS)	-	350,000
4	Brain Storming Meeting (MOES)	-	400,000
5	Geomathematic Winter School Training	34,980	550,000
6	Inspire Fellowship (RLM)	250,400	275,793
7	RTF - DCS Fellowship	-	40,000
8	ULF/VLF Equipment A/c	-	157,881
9	MMMD Workshop	167,774	-
10	Indo-Norwegian Meet	250,000	-
	Total	**906,195**	**1,885,674**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF RECEIPT & PAYMENT AS ON 31ST MARCH 2015

SCHEDULE - 28 : LOANS & ADVANCES/ LIABILITIES (RECEIPTS)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Expenses Payable	109,574	168,303
Income Tax	11,010,347	11,429,226
GPF	22,929,550	21,317,600
Festival Advance	199,350	188,625
Conveyance Advance	242,534	323,783
Computer Advance	243,015	201,417
Sundry Debtors (Party)	12,414,962	38,048,016
Sundry Debtors (Staff)	10,279,111	9,323,299
House Building Advance	153,292	231,908
Security Payable	1,438,187	1,332,215
Subs. Of NPS	2,062,703	1,564,892
Group Insurance	770,942	943,413
PLI	-	828
Uttarakhand Trade Tax	890,082	347,077
C.P.F	334,504	881,449
Co-Operative Society	10,889,991	11,060,625
Refund of HBA	60,000	60,000
CPF Loan	9,840	29,100
GPF Loan	1,350,187	964,925
LIC Premium	1,255,882	1,710,558
HDFC (Dehradun)	738,113	976,594
Warm Clothing Advance	54,225	17,625
Income Tax (Contractor/ Party)	967,800	489,816
Service Tax	618	-
M.C ON NPS	2,062,703	1,564,892
M.C ON CPF	144,385	209,710
A.C.W.F New Delhi	-	500
Accrued Interest on FDR	251,325	-
Consultancy Activity	2,022	2,194,641
PM Rahat Fund	213,993	213,993
Dr B. N. Tiwari	-	127,257
Dr S. K. Parcha	-	319,000
Dr Jayangondaperumal	-	149,402
Dr A. K. Singh	-	318,471
Bhagirathi (PS) Project	-	3,500,000
Yamunotri (VG) Project	-	2,500,000
Centre for Glaciology	-	500,000
Serial Publication, New Delhi	-	675
Satish Prasad Bahuguna	-	200
MPGO Project	-	41,572
WIHG E-Payment	10,000	-
Financial Assistance -Dr. Shivani Panday	1,050,000	-
TOTAL	82,139,237	113,251,607

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF RECEIPT & PAYMENT AS ON 31ST MARCH 2015

SCHEDULE - 29 : LOANS & ADVANCES/ LIABILITIES (PAYMENTS)

(Amt in Rs...)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Expenses Payable	10,477	406,363
Security Payable	2,017,144	1,827,752
Sundey Debtors (Staff)	9,760,282	9,320,019
Sundey Debtors (Party)	15,617,389	37,758,014
Conveyance Advance	506,160	24,000
Computer Advance	169,000	60,200
Income Tax	11,010,347	11,429,226
G.P.F.	22,929,550	21,317,600
Festival Advance	243,000	157,500
Group Insurance	771,188	943,419
PLI	-	828
Uttarakhand Trade Tax	890,082	347,077
C.P.F	334,504	881,449
Co-Operative Society	10,889,991	11,060,625
CPF Loan	9,840	29,100
GPF Loan	1,350,187	964,925
Subs. of NPS	2,062,703	1,564,892
LIC Premium	1,255,882	1,710,558
HDFC (Dehradun)	738,113	976,594
Warm Clothing Advance	81,000	41,250
Income Tax (Contractor/ Party)	967,800	489,816
Service Tax	618	-
Other Recovery (HBA-AKG)	60,000	60,000
Management Contribution on NPS	2,062,703	1,564,892
Management Contribution on CPF	144,385	209,710
A.C.W.F New Delhi	-	500
Accrued Interest on FDR	1,906,149	251,325
Consultancy Activity	421,057	86,160
TDS Recoverable	40,450	196,602
PM Rahat Fund	213,993	213,993
Security Deposit	125,000	170,564
Dr B. N. Tiwari	-	127,257
Dr Jayangondaperumal	-	149,402
Dr A. K. Singh	-	318,471
Dr Rajkumar Singh	-	261,463
Km Vadinaro Imsong	-	228,209
Km Anett Sungla	-	163,545
Indo Iceland	-	1,290,000
Bhagirathi (PS) Project	-	3,500,000
Yamunotri (VG) Project	-	2,500,000
Centre for Glaciology	-	500,000
MPGO Project	41,572	-
Transfer to E-Payment A/c	10,000	
TOTAL	**86,640,566**	**113,103,300**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF RECEIPT & PAYMENT AS ON 31ST MARCH 2015

SCHEDULE - 30 : GRANT - IN - AID (EAR MARKED) REFUND

(Amt in Rs...)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Brain Storming Meeting (MOES)	43,533	-
RTF DCS Fellowship	14,333	
TOTAL	**57,866**	-

SCHEDULE - 31 : LOANS & ADVANCES/ OTHER RECEIPTS, EAR MARKED (RECEIPTS)

(Amt in Rs...)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
4th T.P.E. Workshop	-	100,000
WIHG - IGU Workshop - 2013	-	40,000
MMND Workshop (Dr V.C. Tiwari)	-	50,000
Brain Storming Meeting (Dr PS)	20,000	298,250
Geomathematic Winter School Training	-	78,250
Inspire Fellowship (RLM)	20,000	-
TOTAL	**40,000**	**566,500**

SCHEDULE - 32 : LOANS & ADVANCES/ OTHER PAYMENTS , EAR MARKED (PAYMENTS)

(Amt in Rs...)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
WIHG - IGU Workshop - 2013	-	40,000
MMND Workshop (Dr V.C. Tiwari)	-	50,000
Brain Storming Meeting (Dr PS)	20,000	298,250
Geomathematic Winter School Training	-	78,250
Inspire Fellowship (RLM)	20,000	-
Prof. Misra Award Fund	3,041	-
TOTAL	**43,041**	**466,500**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF RECEIPT & PAYMENT AS ON 31ST MARCH 2015

SCHEDULE - 33 : EAR MARKED FUND EXPENSES

(Amt in Rs…)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
HKT-2015 Workshop - DR. Rajesh Sharma	16,854	-
MMND Workshop (Dr V.C. Tiwari)	-	167,774
Brain Storming Meeting (Dr PS)	184,846	306,467
Geomathematic Winter School Training	-	584,980
Inspire Fellowship (RLM)	231,200	255,793
RTF-DCS Fellowship	-	295,667
WIHG - IGU Workshop - 2013	-	444,048
Indo-Norwegian Meet	201,553	-
TOTAL	**634,453**	**2,054,729**

SCHEDULE - 34 : INVESTMENTS (RECEIPTS)

(Amt in Rs…)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Letter of Credit/ Fixed deposit	89,700,000	1,145,000
TOTAL	**89,700,000**	**1,145,000**

SCHEDULE - 35 : INVESTMENTS (PAYMENTS)

(Amt in Rs…)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Letter of Credit/ Fixed deposit	67,927,350	88,145,000
TOTAL	**67,927,350**	**88,145,000**

(HARISH CHANDRA)	**(DINESH CHANDRA)**	**PROF ANIL K. GUPTA**
Finance & Accounts Officer	Registrar	Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

SCHEDULE FORMING PART OF RECEIPT & PAYMENT AS ON 31ST MARCH 2015

SCHEDULE - 36 : FIXED ASSETS

(Amt in Rs…)

PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
Equipments :		
-WADIA	66,051,736	3,612,039
Field Equipment	-	37,490
Computer & Printers	1,086,854	803,319
Office Equipment	3,096,920	1,292,670
Building Construction	7,086,833	3,803,977
Books & Charts	11,758,311	11,555,306
Furniture & Fixture	174,441	193,921
Building under Construction -WIP	1,077,419	
TOTAL	**90,332,514**	**21,298,722**
Equipments :		
-PROJECTS	-	1,420,121
TOTAL	-	1,420,121
GRAND TOTAL	**90,332,514**	**22,718,843**
Add: (Profit)/Loss on asset		
- Vehicle	-	-
- Equipment	-	3,008,197
- Library Books	(369)	(418)
- Furniture & Fixtures	-	295,257
Less :- Fixed Assets Written Off		
- Vehicle	-	-
- Library Books	480	746
- Equipment Indeginious	-	12,949,290
- Field Equipment	-	388,717
- Office Equipment	-	4,203,575
- Computer	-	-
- Furniture & Fixtures	-	1,070,224
Add: Depreciation Fund reversed		
- Vehicle	-	-
- Library Books	369	418
- Equipment	-	13,317,216
- Computer	-	-
- Furniture & Fixtures	-	655,598
Projects	-	1,420,121
	90,332,034	**19,962,438**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

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WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

ANNEXURE '1'
[SUNDRY CREDITORS AS ON 31st MARCH 2015]

(Amt in Rs...)

S.NO.	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Dr. S. K. Parcha	319,000	319,000
2	C. D. S. Project (PB)	15,000	15,000
3	Serial Publication, New Delhi	675	675
4	MPGO PROJECT	-	41,572
5	Sri Satish Prasad Bahuguna	200	200
6	Financial Assistance -Dr. Shivani Panday	1,050,000	-
	Total	**1,384,875**	**376,447**

'ANNEXURE '2'
[PUBLICATION AS ON 31st MARCH 2015]

(Amt in Rs...)

S.NO.	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	**Opening Stock of Himalayan Geology Volume**	**416,149**	**488,702**
2	Less : Closing Stock of Himalayan Geology Volume	379,097	416,149
	Decrease In Stock	**37,052**	**72,553**

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Finance & Accounts Officer	Registrar	Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRADUN

ANNEXURE '3'
{ PARTY DEBTORS AS ON 31st MARCH 2015 }

(Amt in Rs...)

S.NO.	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Sh. Dharam Singh Manral	5,000	5,000
2	Registrar Banaras University	2,500	2,500
3	M/s NRSA, Hyderabad	(11,634)	(11,634)
4	M/s Associated Cement Corp.	39,320	39,320
5	M/s Cement Corporation Of India	6,409	6,409
6	Registrar Roorkee University	3,250	3,250
7	M/s C.Z.Instruments	18,622	18,622
8	M/s Indian Photographics Co.	6,876	6,876
9	M/s Scientronics Inst. Co.	3,004	3,004
10	I.I.P. D. Dun	7,200	7,200
11	M/s Airport Handling Service	40,697	58,493
12	M/s Philips Electronics Inf.	3,193	3,193
13	M/s Indian Rave Earth Ltd.	3,221	3,221
14	M/s Instrument Traders	2,481	2,481
15	M/s Bharat ICP Corp.	3,000	3,000
16	M/s Survey Of India	5,000	5,000
17	M/s Eureka Forbes	1,300	1,300
18	M/s Jakson Enterprises	16,545	16,545
19	M/s Gatan House, Hyderabad	-	(376)
20	M/s Track Cargo, Delhi	92,719	117,458
21	Shri H. G. Malik (Advocate)	14,000	14,000
22	M/s. INSA, New Delhi	-	12,880
23	M/s. Mittal Machines Pvt. Ltd.	3,409,975	-
24	Sharda Infra Engr.	(152,509)	-
	TOTAL	**3,520,169**	**317,742**

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(DINESH CHANDRA)
Registrar

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AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

ANNEXURE '4'
[IMPREST MONEY AS ON 31ST MARCH 2015]

(Amt in Rs...)

S.NO	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Dr.V.C. Tiwari	0	2,000
2	Dr. N. K. Saini	0	1,000
3	Shri O. P. Anand	0	(2,000)
4	Shri S. K. Parcha	0	9,000
5	Shri Manas Kumar Biswas	0	5,000
6	Shri Tajender Kumar Ahuja	0	2,000
7	Shri C. B.Sharma (JE)	0	2,000
8	Dr. B. K. Chowdhury	0	2,000
9	Dr. Kishore Kumar	0	7,000
10	Dr. H. K. Sachan	0	5,000
11	Shri Rambir Kaushik	0	5,000
12	Mrs. Anita Chowdhary	0	2,000
13	Km Richa Kukreja	0	10,000
14	Sri Girish Chand Singh	0	2,000
	TOTAL	**0**	**52,000**

ANNEXURE '5'
[STAFF ADVANCES AS ON 31ST MARCH 2015]

(Amt in Rs...)

S.NO	PARTICULARS	INEXU	CURRENT YEAR	PREVIOUS YEAR
1	Festival Advance	6	113,775	70,125
2	Conveyance Advance	7	611,181	347,555
3	House Building Advance	8	562,806	716,098
4	Computer Advance	9	414,672	488,687
5	Advance for Expenses (Staff Debtors)	10	244,599	763,428
6	Warm Clothing Advance	11	50,400	23,625
7	Consultancy Activity		291,736	100,200
	TOTAL		**2,289,169**	**2,509,718**

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WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

'ANNEXURE 'A'

(FESTIVAL ADVANCE AS ON 31st MARCH 2015)

(Amt in Rs...)

S.NO	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Shri S. K. Chabak	2,700	1,875
2	Shri C. P. Dabral	2,700	1,875
3	Shri B. B. Panthari	2,700	1,875
4	Smt. Rama Pant	1,350	1,125
5	Shri Ramesh Chand	1,350	1,125
6	Shri Nain Dass	2,250	1,875
7	Shri Khushi Ram	1,275	1,050
8	Shri R. S. Negi	2,250	-
9	Shri Madhu Sudan	2,250	1,875
10	Shri Vinod Singh Rawat	2,250	-
11	Shri Hari Krishan	2,250	750
12	Shri Ramesh	1,350	1,125
13	Shri Rajeev Yadav	2,250	-
14	Shri Navneet Kumar	2,250	1,125
15	Shri Nand Ram	2,250	1,875
16	Shri M. S. Rawat	2,250	-
17	Shri Shyam Singh	2,625	2,250
18	Shri S. K. Srivastava	3,600	-
19	Shri Shekhar Nand	1,275	1,050
20	Shri Ram Kishore	2,250	1,875
21	Shri Pratap Singh	-	1,125
22	Shri Amaya Prasad	2,700	1,875
23	Shri Shiv Prasad Bahuguna	2,250	1,875
24	Shri Shashidhar Prasad Balodi	2,250	1,875
25	Shri S. K. Thapliyal	1,275	1,050
26	Shri Lokeshwar Vashist	2,700	-
27	Shri Balram Singh	3,600	3,375
28	Shri Tirath Raj	2,700	1,875
29	Shri Sohan Singh	2,250	1,875
30	Shri Hari Singh Chauhan	1,350	1,875
31	Shri Rahul Sharma	2,250	1,875
32	Shri Kulwant Singh Manral	2,250	1,875
33	Dr. Jitender Bhatt	2,250	-
34	Mrs. Kalpana Chandel	2,250	1,875
35	Shri S. K. Gupta	2,250	1,875
36	Shri Surendra Singh	1,350	-
37	Shri Chait Ram	1,350	1,125
38	Mrs. Seema Juyal	1,875	1,500
39	Shri Santu Das	1,650	1,425
40	Mrs. Neelam Chabak	2,700	1,875
41	Shri Ravi Lal	1,350	1,125
42	Shri Pretam Singh	2,550	1,050
43	Shri Bharat Singh Rana	1,350	1,125
44	Smt. Omwati	2,250	1,875
45	Shri Preetam Singh	1,350	1,125
46	Shri M. C. Sharma	-	1,875
47	Mrs. Pratibha Kharbanda	2,250	1,875
48	Shri Vijay Ram Bhatt	2,250	1,875
49	Shri Bhupender Singh	-	2,250
50	Shri Puneet Kumar	-	1,125
51	Shri Jeevan Lal	2,250	1,875
52	Sri. Laxman Singh Bhandari	2,250	-
53	Sri. Rahul Loadh	2,250	-
54	Smt. Sarita Gautam	2,250	-
55	Sri. Deepak Tiwari	2,250	-
56	Sri. Ajay Uppadaya	2,250	-
57	Km. Salini Negi	2,250	-
	TOTAL	113,775	79,125

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Finance & Accounts Officer

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WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

ANNEXURE '7'
[CONVEYANCE ADVANCE AS ON 31ST MARCH 2015]

(Amt in Rs...)

S.NO.	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Shri C. P. Dabral	4,748	9,884
2	Mrs. Seema Juyal	21,000	-
3	Dr. Dilip Kumar Yadav	158,080	-
4	Shri Pretam Singh	27,500	-
5	Shri Koushik Sen	159,400	-
6	Dr. P. P. Khanna	3,200	22,400
7	Dr. B. N. Tiwari	18,478	31,522
8	Sri. Rahul Lodh	27,000	-
9	Shri Param Kirti Rao Gautam	2,000	14,000
10	Shri Samay Singh	91,885	115,345
11	Shri Rakesh Kumar	1,705	5,821
12	Dr. Devajit Hazarika	-	4,748
13	Dr. A. K. L.Ashthana	-	39,850
14	Shri Chander Shekhar	-	10,000
15	Shri S. K. Gupta	4,325	7,745
16	Shri Madhu Sudan	14,556	19,704
17	Shri Navneet Kumar	11,309	15,425
18	Shri Shyam Singh	11,995	16,111
19	Shri S. S. Bhandari	16,000	-
20	Mrs. Prabha Kharbanda	-	11,000
21	Sri Chait Ram	13,000	24,000
22	Sri M. S. Rawat	25,000	-
	TOTAL	**611,181**	**347,555**

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WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRADUN

ANNEXURE '8'
[HOUSE BUILDING ADVANCE AS ON 31st MARCH 2015]

(Amt in Rs…)

S.NO.	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Dr Rajesh Sharma	62,352	109,104
2	Shri. Anand Singh Negi	9,460	23,800
3	Mrs. Rajvinder Nagpal	59,592	76,584
4	Shri. Ansuya Prasad	-	9,080
5	Shri. D. Rameshwar Rao	-	456
6	Dr. George Philip	-	13,760
7	Shri Rakesh Kumar	125,900	145,940
8	Dr. A.K Singh	305,502	337,374
	TOTAL	**562,806**	**716,098**

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AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRADUN

ANNEXURE ' 9'

(COMPUTER ADVANCE AS ON 31st MARCH 2015)

(Amt in Rs...)

S.NO.	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Shri S.K Chabak	15,800	18,200
2	Shri C P Dabral	11,200	13,600
3	Dr. A K Mahajan	-	11,513
4	Shri Lokeshwar Vashist	11,200	13,600
5	Shri Kalpana Chandel	23,000	-
6	Shri Hukam Singh	800	12,800
7	Shri Vinod Singh Rawat	11,200	13,600
8	Shri Abhey Kumar Pandit	-	13,600
9	Mrs. Prabha Kharbanda	13,600	-
10	Shri V K Kala	-	13,600
11	Shri. Navneet Kumar	-	6,000
12	Shri Ram Kishore	11,200	13,600
13	Shri Ramesh Chandra Arya	13,600	16,000
14	Shri Shiv Prasad Bahuguna	12,200	14,600
15	Shri Shashidhar Prasad Balodi	-	8,800
16	Shri Pretam Singh	27,500	-
17	Shri Rajender Prakash	6,600	10,200
18	Shri S S Bisht	-	13,600
19	Shri Narendera Singh Meena	69,947	-
20	Mrs Prabha Kharbanda	-	16,000
21	Shri Ramesh Kumar Sehgal	11,200	13,600
22	Shri Chander Shekher	-	13,600
23	Shri S C Kothiyal	11,200	13,600
24	Shri Samay Singh	11,200	13,600
25	Shri Santu Dass	13,600	16,000
26	Mrs.Neelam Chabak	17,000	19,400
27	Dr Sushil Kumar	11,200	13,600
28	Shri Rakesh Kumar	5,000	14,600
29	Dr.A.K.Singh	-	4,649
30	Dr. Khyanshing Luirei	-	6,000
31	Dr. Ajay Paul	13,600	16,000
32	Shri Pankaj Chauhan	10,225	17,425
33	Smt. Rama Pant	8,400	22,800
34	Shri Madhu Sudan	6,000	12,000
35	Shri Anusya Prasad	2,500	8,500
36	Mrs. Anita Chowdhary	1,000	7,000
37	Shri B.B. Saran	1,000	7,000
38	Shri Kaushik Sen	6,000	12,000
39	Shri Rahul Loadh	26,500	-
40	Shri Nain Dass	15,200	20,000
41	Mrs Seema Juyal	16,000	28,000
	TOTAL	414,672	488,687

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Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRADUN

ANNEXURE '10'
[STAFF DEBTORS AS ON 31st MARCH 2015]

(Amt in Rs…)

S.NO.	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Sh.Shaid Farooq	2,500	2,500
2	Sh.Rohlu Ram	1,713	1,711
3	Sh. G.D. Sharma	-	(1,419)
4	Sh. S.S.Rawat	1,878	1,878
5	Km. L.Nair (Jrf)	5,136	5,136
6	Sh. R.M. Sharma	11,303	22,209
7	Sh. S.K.Sharma (Jrf)	225	225
8	Sh. R.N.Pandey	1,300	1,300
9	Sh. S.K. Mehra (Jrf)	5,000	5,000
10	Sh. Bharosa Nand	73	663
11	Sh. Hari Singh Manral	3,143	-
12	Sh. Rakesh Mohan (Jrf)	4,173	4,173
13	Sh. Alok Kumar Singh	1,300	1,300
14	Sh. Tikam Singh	532	-
15	Scientist Incharge	(32,729)	(32,729)
16	Dr. Iqrar Ahmed	1,320	1,320
17	Sh. Kali Dass	4,439	1,780
18	Dr.V.C.Tiwari	-	195,954
19	Dr.B.K.Chowdhury	-	146,836
20	Sh Laxman Singh Bhandari	(2,400)	-
21	Shri P.S. Negi	2,529	102,529
22	Shri M. S. Rawat	(2,500)	12,384
23	Prof. A. K. Gupta	-	255,600
24	Shri B. S Rawat	-	78
25	Shri Anil Kumar, S. R. A.	-	31,500
26	Dr. Devajit Hazarika	-	3,500
27	Sri. V. Sriram	11,700	-
28	Sri. R. S. Negi	2,500	-
29	Dr. S. K. Ghosh	117,000	-
30	Sri. Rajesh Yadav, Driver-CDL	10,000	-
31	Sri. Rahul Sharma	8,000	-
32	Dr. Somdutt Sharma, JRF	14,000	-
33	Dr. Santosh Kumar Rai	70,064	-
34	Sri. Pradeep Kumar	2,400	-
	GRAND TOTAL	**244,599**	**763,428**

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WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRADUN

ANNEXURE '11'
(WARM CLOTHING ADVANCE AS ON 31st MARCH 2015)

(Amt in Rs...)

S.NO	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Shri Ramesh Chand	2,700	1,875
2	Sri M. S. Rawat	-	2,250
3	Sri Khushi Ram	-	2,250
4	Sri Hari Kishan	-	2,250
5	Sri Ramesh	-	2,250
6	Sri Ram Kishore	-	2,250
7	Sri Chait Ram	-	1,875
8	Sri Ravi Lal	-	2,250
9	Sri Pretam Singh	-	2,250
10	Sri Preetam Singh	-	1,875
11	Sri Rahul Loadh	-	2,250
12	Sri. Nain Dass	2,700	-
13	Sri. R. S. Negi	2,700	-
14	Sri. Vinod Singh Rawat	2,700	-
15	Sri. Madhu Sudan	4,500	-
16	Sri. Ansuya Prasad	2,700	-
17	Sri. S.K. Srivastava	2,700	-
18	Mrs. Kalpana Chandel	2,700	-
19	Sri. S. K. Gupta	2,700	-
20	Mrs. Seema Juyal	2,700	-
21	Sri. Shiv Singh Negi	2,700	-
22	Km. Richa Kukreja	2,700	-
23	Sri. Rahul Sharma	2,700	-
24	Sri. Kulwant Singh Manral	2,700	-
25	Smt. Sarita Gautan	2,700	-
26	Sri. Deepak tiwari	2,700	-
27	Sri. Ajay Uppadaya	2,700	-
28	Km. Salini Negi	2,700	-
	TOTAL	**50,400**	**23,625**

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WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRADUN

ANNEXURE '12'
[SECURITY DEPOSIT AS ON 31ST MARCH 2015]

(Amt in Rs...)

S.NO	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	M/s BOC India Ltd. Faridabad	16,000	16,000
2	M/s. UPCL (Security Against Electricity)	595,912	595,912
3	M/s. Garhwal Jal Sansthan	460	460
4	M/s. Lal Brothers	9,000	9,000
5	M/s. Indian Oxygen Ltd.	52,000	52,000
6	M/s. Vallay Gas Service	500	500
7	M/s. BSNL (Security Against Telephones)	215,500	215,500
8	M/s. Bharti Airtel Co.	3,000	3,000
9	M/s. Linde India Ltd.	125,000	-
	TOTAL	**1,017,372**	**892,372**

ANNEXURE '13'
[FEES FOR MISCELLENOUS SERVICES AS ON 31ST MARCH 2015]

(Amt in Rs…)

S.NO	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Licence Fees	189,030	186,489
2	Transportation Charges	6,600	27,300
3	Electricity & Water Charges	492,097	353,211
	TOTAL	**687,727**	**567,000**

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

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Director

AUDITOR'S REPORT

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WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

ANNEXURE '14'
[MISCELLANEOUS INCOME AS ON 31ST MARCH 2015]

(Amt in Rs...)

S.NO	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Insurance Damage Claim	-	2,414
2	EMD Forfeited	-	20,000
3	Other Receipts		
	a)Misc.	28,808	11,140
	b)Vehicle charges (Pvt. Purpose)	14,948	20,990
	c) Consultancy Receipts	4,250,231	4,373,861
	d) 24th ICMS Conference 2013	75,000	246,000
4	Xerox Charges	330	-
5	Fee For Information Act-2005	176	190
	TOTAL	**4,369,493**	**4,674,595**

ANNEXURE '15'
[EXPENSES ON SEMINAR/ WORKSHOPS AS ON 31ST MARCH 2015]

(Amt in Rs...)

S.NO	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	**Seminar/Workshop/Conference**		
	a) Expenses on Conference in India	144,961	407,769
	b) Expenses on Conference held abroad	450,521	176,093
	c) Professor D.N. Wadia Lecture Series	12,207	68,988
	d) 4th T.P.E. Workshop	-	1,169,105
	e) 24th ICMS Conference 2013	-	1,371,739
	TOTAL	**607,689**	**3,193,694**

(HARISH CHANDRA)
(Finance & Accounts Officer)

(DINESH CHANDRA)
Registrar

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Director

FRN 013106C

ANNEXURE '16'
[EXPENSES PAYABLE AS ON 31ST MARCH 2015]

(Amt in Rs…)

S.NO	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	UHPM Project	-	1,627
2	EPGPS (PB)	-	500
3	QCTLKH	-	940
4	FCRA Project	-	504
5	Ganga Basin	-	504
6	EREC (SKP) Project	-	504
7	ILTP- NEMFIS (VR) Project	-	494
8	Dr. V. M. Choubey	10,000	10,000
9	C. S. I. R (AS)	-	1,000
10	ESRS (ACN) Project	-	564
11	HMGI (PCS) Project	-	938
12	Dr. B. K. Chowdhary	100,000	-
13	SMFH Project (ACN)	1,000	-
14	UGC (RC) Project	1,548	-
15	BEAO (RS) Project	1,124	-
16	Bhagirathi (PS) Project	1,000	-
17	Yamnotri (VG) Project	1,000	-
18	DST Inspire (SB) PROJECT	1,000	-
	TOTAL	**116,672**	**17,575**

(HARISH CHANDRA)
(Finance & Accounts Officer)

(DINESH CHANDRA)
Registrar

(PROF ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

ANNEXURE '17'
[SECURITY PAYABLE AS ON 31ST MARCH 2015]

(Amt in Rs...)

S.NO	PARTICULARS	CURRENT YEAR	PREVIOUS YEAR
1	Sri. J.P. Singh	1,000	1,000
2	M/S. Zamil Parvez, DDun	2,000	2,000
3	Sri. K.N.Sahni DDun	5,000	5,000
4	Atikul Rehman	5,000	5,000
5	M/s. Pentech Instrument	2,000	2,000
6	ONGC Retired Officers Coop. Society	-	50,000
7	M/s Virender Elec.	2,100	2,100
8	Guardwell Security Services	-	50,000
9	M/s Radix Technologies	5,000	5,000
10	IR Tech Services N.Delhi	6,000	6,000
11	EICON Technology DDN	20,000	20,000
12	Pest Control India Ltd	86,896	86,896
13	Tej Technology Hybd	20,000	20,000
14	Polutn Equipt Cont Ndel	9,000	9,000
15	M/s. Cetac Technology	376,540	376,540
16	Mahindra & Mahindra Ltd	1,813	1,813
17	M/s. Algade Sas	58,350	58,350
18	M/s. Rawat Sanitation	1,246	1,246
19	M/s. Mountarian Equipment	4,850	4,850
20	M/s. Dev Associates	70,000	70,000
21	M/s. Dec-N-Drap, N.Delhi	20,000	1,523,278
22	M/s. Bil Trading N Del	20,000	20,000
23	Indian Book House Ddn	2,000	2,000
24	SWJ Associates	3,091	3,091
25	M/s. Doon Light Asso. , DDun	88,832	102,468
26	M/s. Sulaksh Inters. Delhi	722,002	200,000
27	M/s. Sharda Infra Engr.	436,505	144,196
28	M/s. Shashi Buildcon Pvt. Ltd.	39,055	39,055
29	M/s. Progressive Engr. Service	223,405	75,000
30	M/s. A. R. Enterprises	145,900	145,900
31	M/s. Raj Power, Delhi	-	187,000
32	M/s. Shekhawati Elect. Engnr	-	187,000
33	M/s. Neo Fitness & Sports	3,500	-
34	M/s. Indian Security Guard	50,000	-
35	M/s. Good House Keeping	50,000	-
36	M/s. Prem Mahan Enterprises	14,961	-
37	M/s. V. Ventures	19,780	-
38	M/s. R. P. Construction Co.	213,000	-
39	M/s. Argus Tecno Const.	98,000	-
	TOTAL	**2,826,826**	**3,405,783**

(HARISH CHANDRA)	**(DINESH CHANDRA)**	**(PROF ANIL K. GUPTA)**
Finance & Accounts Officer	Registrar	Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

ANNEXURE 1F

(Amt in Rs...)

	PARTICULARS	GROSS BLOCK				DEPRECIATION					NET BLOCK		
		COST AT THE BEGINNING OF THE YEAR	ADDITION DURING THE YEAR	DED./WRITTEN OFF / TRFD. DURING THE YR	COST AT THE END OF THE YEAR	OPENING BALANCE	OPENING BAL. TFD FROM PROJECT	ON ADDITIONS	DED./WRITT OFF / TRFD DURING THE YR.	TOTAL	CURRENT YEAR	PREVIOUS YEAR	RATE OF DEP.
	Projects												
1	GPS Equipment	13,083,695	-	-	13,083,695	10,053,290	-	454,561	-	10,507,851	2,575,844	3,030,405	15%
2	Neotectonic Project (S. Kumar)	314,552	-	-	314,552	241,697	-	10,928	-	252,625	61,927	72,855	15%
3	Neotectonic Project(VCT)	32,760	-	-	32,760	25,171	-	1,138	-	26,309	6,451	7,589	15%
4	CSIR Project(VCT)	40,000	-	-	40,000	30,735	-	1,390	-	32,125	7,875	9,265	15%
5	PAC(AP) Project(TS)	345,430	-	-	345,430	265,423	-	12,001	-	277,424	68,006	80,007	15%
6	SNWH Project (SKP)	16,150	-	-	16,150	12,410	-	561	-	12,971	3,179	3,740	15%
7	PILOT Project(JTG)	249,442	-	-	249,442	191,668	-	8,666	-	200,334	49,108	57,774	15%
8	SDB Project(SK)	505,504	-	-	505,504	388,421	-	17,562	-	405,983	99,521	117,083	15%
9	LSZ Project(NSV)	19,314	-	-	19,314	14,841	-	671	-	15,512	3,802	4,473	15%
10	DFSZ Project (HKS)	588,352	-	-	588,352	452,080	-	20,441	-	472,521	115,831	136,272	15%
11	HIA Project (AB)	33,878	-	-	33,878	26,032	-	1,177	-	27,209	6,669	7,846	15%
12	HRGH Project (NRP)	185,980	-	-	185,980	142,903	-	6,462	-	149,365	36,615	43,077	15%
13	ESS Project(SKP)	464,499	-	-	464,499	356,914	-	16,138	-	373,052	91,447	107,585	15%
14	SHA Project (AKM)	71,360	-	-	71,360	54,832	-	2,479	-	57,311	14,049	16,528	15%
15	EHA Project (TNB)	160,966	-	-	160,966	123,683	-	5,592	-	129,275	31,691	37,283	15%
	Balance Carried Forward	16,111,882	-	-	16,111,882	12,380,100	-	559,767	-	12,939,867	3,172,015	3,731,782	

Contd.2.

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

ANNEXURE 18'

(Amt in Rs...)

	PARTICULARS	GROSS BLOCK				DEPRECIATION					NET BLOCK		
		COST AT THE BEGINNING OF THE YEAR	ADDITION DURING THE YEAR	DED./WRITTEN OFF / TRFD. DURING THE YR	COST AT THE END OF THE YEAR	OPENING BALANCE	OPENING BAL. TFD FROM PROJECT	ON ADDITIONS	DED./WRITT OFF / TRFD DURING THE YR.	TOTAL	CURRENT YEAR	PREVIOUS YEAR	RATE OF DEP.
	Balance Brought Forward	**16,111,882**	-	-	**16,111,882**	**12,380,100**	-	**559,767**	-	**12,939,867**	**3,172,015**	**3,731,782**	
16	ILHDR Project (RK)	713,860	-	-	713,860	548,518	-	24,801	-	573,319	140,541	165,342	15%
17	SSTH Project	4,508,227	-	-	4,508,227	3,464,045	-	156,627	-	3,620,672	887,555	1,044,182	15%
18	RMGC Project (SJS)	1,603,022	-	-	1,603,022	1,231,828	-	55,679	-	1,287,507	315,515	371,194	15%
19	PTS Project (HR)	90,112	-	-	90,112	69,166	-	3,142	-	72,308	17,804	20,946	15%
20	CE Project (NSM)	56,421	-	-	56,421	43,353	-	1,960	-	45,313	11,108	13,068	15%
21	ESTG Project	101,611	-	-	101,611	78,075	-	3,530	-	81,605	20,006	23,536	15%
22	PBP MT Project (MT)	129,149	-	-	129,149	99,236	-	4,487	-	103,723	25,426	29,913	15%
23	EPGPS PRO (PB)	5,606,753	-	-	5,606,753	4,308,134	-	194,793	-	4,502,927	1,103,826	1,298,619	15%
24	LHZ SILROOT PROJECT (GP)	109,958	-	-	109,958	84,491	-	3,820	-	88,311	21,647	25,467	15%
25	UHPM PROJECT (HKS)	80,409	-	-	80,409	60,998	-	2,912	-	63,910	16,499	19,411	15%
26	BSS (KPJ) PROJECT	43,790	-	-	43,790	33,647	-	1,521	-	35,168	8,622	10,143	15%
27	FMD (AKD) PROJECT	188,392	-	-	188,392	144,757	-	6,545	-	151,302	37,090	43,635	15%
28	SSR-NCR PROJECT	9,657,406	-	-	9,657,406	7,420,587	-	335,523	-	7,756,110	1,901,296	2,236,819	15%
29	MGGS-NCS PROJECT	96,903	-	-	96,903	74,459	-	3,367	-	77,826	19,077	22,444	15%
30	EGLLT PROJECT (NSV)	703,060	-	-	703,060	540,220	-	24,426	-	564,646	138,414	162,840	15%
31	AFNAH-I PROJECT (NSV)	74,940	-	-	74,940	57,583	-	2,604	-	60,187	14,753	17,357	15%
32	RPL PROJECT (VG)	415,306	-	-	415,306	300,684	-	16,893	-	317,577	95,729	112,622	15%
33	ILTP (K)	25,350	-	-	25,350	18,442	-	1,036	-	19,478	5,872	6,908	15%
	Balance Carried Forward	**40,314,551**	-	-	**40,314,551**	**30,958,323**	-	**[illegible]**	-	**32,361,756**	**7,952,795**	**9,356,218**	

Contd.3.

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

ANNEXURE 1F

(Amt in Rs...)

	PARTICULARS	GROSS BLOCK				DEPRECIATION					NET BLOCK		
		COST AT THE BEGINNING OF THE YEAR	ADDITION DURING THE YEAR	DED./WRITTEN OFF / TRFD. DURING THE YR	COST AT THE END OF THE YEAR	OPENING BALANCE	OPENING BAL. TFD FROM PROJECT	ON ADDITIONS	DED./WRITT OFF / TRFD DURING THE YR.	TOTAL	CURRENT YEAR	PREVIOUS YEAR	RATE OF DEP.
	Balance Brought Forward	40,314,551	-	-	40,314,551	30,958,323	-	1,403,433	-	32,361,756	7,952,795	9,356,228	
34	EGMS PRO. (PB)	845,448	-	-	845,448	649,628	-	29,373	-	679,001	166,447	195,820	15%
35	LHZ PRO.(GP)	60,315	-	-	60,315	46,344	-	2,096	-	48,440	11,875	13,971	15%
36	SEISMOCITY (TNB)	25,000	-	-	25,000	19,210	-	869	-	20,079	4,921	5,790	15%
37	CSIR (KNK)	208,237	-	-	208,237	160,005	-	7,235	-	167,240	40,997	48,232	15%
38	PREKS (SKP)	166,478	-	-	166,478	127,919	-	5,784	-	133,703	32,775	38,559	15%
39	ONGC (RANGA RAO)	28,183	-	-	28,183	21,655	-	979	-	22,634	5,549	6,528	15%
40	CSIR (V-RAIVERMAN)	50,800	-	-	50,800	39,034	-	1,765	-	40,799	10,001	11,766	15%
41	PGC PROJECT (AKS)	69,591	-	-	69,591	53,206	-	2,458	-	55,664	13,927	16,385	15%
42	PBRD (VCT)	87,760	-	-	87,760	67,433	-	3,049	-	70,482	17,278	20,327	15%
43	MBGH (JTG)	2,441,537	-	-	2,441,537	1,876,036	-	84,825	-	1,960,861	480,676	565,501	15%
44	TOTAL STATION	2,414,225	-	-	2,414,225	1,855,050	-	83,876	-	1,938,926	475,299	559,175	15%
45	CDS (PB) PRO	4,152,662	-	-	4,152,662	3,190,834	-	144,274	-	3,335,108	817,554	961,828	15%
46	SEISMO GPS (PB) PRO	14,846,853	-	-	14,846,853	10,554,436	-	643,863	-	11,198,299	3,648,554	4,292,417	15%
47	DDBC (BS)	383,004	-	-	383,004	294,294	-	13,307	-	307,601	75,403	88,710	15%
48	SIACHIN GLR (HKS)	95,160	-	-	95,160	64,671	-	4,573	-	69,244	25,916	30,489	15%
49	EREC (SKP) PRO	1,010,208	-	-	1,010,208	721,547	-	43,299	-	764,846	245,362	288,661	15%
50	ECD(BR) PROJECT	10,326,133		-	10,326,133	6,995,646		499,573	-	7,495,219	2,830,914	3,330,487	15%
51	GANGA BASIN PROJECT	51,521		-	51,521	28,661		3,429	-	32,090	19,431	22,860	15%
	Balance Carried Forward	77,877,666	-	-	77,877,666	57,723,932	-	2,978,060	-	60,701,992	16,875,674	19,853,734	

Contd.4.

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

ANNEXURE 18'

(Amt in Rs...)

	PARTICULARS	GROSS BLOCK				DEPRECIATION					NET BLOCK		
		COST AT THE BEGINNING OF THE YEAR	ADDITION DURING THE YEAR	DED./WRITTEN OFF / TRFD. DURING THE YR	COST AT THE END OF THE YEAR	OPENING BALANCE	OPENING BAL. TFD FROM PROJECT	ON ADDITIONS	DED./WRITT OFF / TRFD DURING THE YR.	TOTAL	CURRENT YEAR	PREVIOUS YEAR	RATE OF DEP.
	Balance Brought Forward	77,577,666	-	-	77,577,666	57,723,932	-	2,978,060	-	60,701,992	16,875,674	19,853,734	
52	AFNAH II (NSV)	40,000		-	40,000	22,252		2,662	-	24,914	15,086	17,748	15%
53	ILTP- NEMFS(AKM)	42,453		-	42,453	26,442		2,402	-	28,844	13,609	16,011	15%
54	ECGHR (GP)	309,670		-	309,670	237,945		10,759	-	248,704	60,966	71,725	15%
55	MGIE(BRA)	5,117,709		-	5,117,709	3,723,181		209,179	-	3,932,360	1,185,349	1,394,528	15%
56	GEES (BKC)	4,463,573		-	4,463,573	2,796,043		250,130	-	3,046,173	1,417,400	1,667,530	15%
57	NRDMS PROJECT	1,343,415	-	-	1,343,415	1,178,859	-	24,683	-	1,203,542	139,873	164,556	15%
58	ESR PROJECT (ACN)	76,706	-	-	76,706	59,282	-	2,614	-	61,896	14,810	17,424	15%
	TOTAL	88,971,192	-	-	88,971,192	65,767,936	-	3,480,489	-	65,248,425	19,722,767	23,203,256	

(HARISH CHANDRA)
Finance & Accounts Officer

(DINESH CHANDRA)
Registrar

(PROF. ANIL K. GUPTA)
Director

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN

ANNEXURE '19'
[PROFIT/LOSS ON SALE OF ASSET AS ON 31ST MARCH 2015]

(Amt in Rs....)

PARTICULARS	SCH	CURRENT YEAR	PREVIOUS YEAR
Vehicle			
Gross Value	8	-	-
Less: Accumulated Dep	8	-	-
Net Value		-	-
Less: Sold during the Year	18	-	-
Loss on sale	(A)	-	-
Library Books			
Gross Value	8	480	746
Less: Accumulated Dep	8	369	418
Net Value		111	328
Less: Sold during the Year	18	480	746
(Profit)/Loss on sale	(B)	(369)	(418)
Equipment			
Gross Value	8	-	17,541,582
Less: Accumulated Dep	8	-	13,317,216
Net Value		-	4,224,366
Less: Sold during the Year	18	-	1,216,169
(Profit)/Loss on sale	(C)	-	3,008,197
Furniture & Fixtures			
Gross Value	8	-	1,070,224
Less: Accumulated Dep	8	-	655,598
Net Value		-	414,626
Less: Sold during the Year	18	-	119,368
(Profit)/Loss on sale	(D)	-	295,257.00
Total (Profit)/Loss (A+B+C+D)		(369)	3,303,036

(HARISH CHANDRA)	**(DINESH CHANDRA)**	**(PROF ANIL K. GUPTA)**
Finance & Accounts Officer	Registrar	Director

AUDITOR'S REPORT

WADIA INSTITUTE OF HIMALAYAN GEOLOGY,
33, GMS ROAD DEHRADUN

SCHEDULE FORMING PART OF ACCOUNTS FOR THE YEAR ENDED 31ST MARCH, 2015

SCHEDULE – 37: SIGNIFICANT ACCOUNTING POLICIES

1. ACOUNTING CONVENTION

   The financial statements are prepared on the basis of historical cost convention, unless otherwise stated and on the cash method of accounting except interest accrued on fixed deposit.

2. INVESTMENTS

   Investments classifieds as "long term investments" are carried at cost.

3. FIXED ASSETS

   a) Fixed Assets are stated at net book value as recommended in the "Uniform Accounting Format" of financial statements for the Central Autonomous Bodies as made compulsory by the Ministry of Finance w.e.f. 01.04.2001.
   b) Additions to fixed assets are taken at cost of acquisition, inclusive of freight, duties and taxes, incidental and direct expenses related to acquisition.

4. DEPRECIATION

   a) Depreciation is provided on Written down Value method as per rates specified in the Income Tax Act, 1961.

   b) When an asset is discarded or sold or deleted, the original cost is deducted from the gross block, the W.D.V. is deducted from the W.D.V. block and accumulated depreciation on the asset upto the date of deletion is deducted from accumulated depreciation of the respective block.

   c) In respect of addition to/ deduction from fixed assets during the year, depreciation is considered on full yearly basis.

WADIA INSTITUTE OF HIMALAYAN GEOLOGY,
33, GMS ROAD DEHRADUN

5. MISCELLANEOUS EXPENDITURE

Deferred revenue expenditure, if any, will be written off over a period of 5 years from the year it is incurred.

6. ACCOUNTING FOR SALES & SERVICES

The consultancy services provided by the institute is accounted for on net service basis.

7. GOVERNMENT GRANTS / SUBSIDIES

a) Government grants of the nature of contribution towards Capital Cost and Revenue cost are transferred to Income & Expenditure account and the surplus or deficit after deducting all the expenses is transferred to Capital / Corpus fund.

b) Grants towards Earmarked / Endowment Funds are directly transferred to the respective fund account.

c) Government grants / subsidy are accounted on realization basis.

(Harish Chandra) **Finance & Accounts Officer**	**(Dinesh Chandra)** **Registrar**	**(Prof. Anil K. Gupta)** **Director**

Date : 30th June, 2015
Place: Dehradun

WADIA INSTITUTE OF HIMALAYAN GEOLOGY,
33 GMS ROAD, DEHRADUN

SCHEDULE FORMING PART OF ACCOUNTS FOR THE YEAR ENDED 31ST MARCH, 2015

SCHEDULE – 38: CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS

1. CONTINGENT LIABILITIES

(Amount in Rs.)

a)	Claims against the Entity not acknowledged as debts		- Nil -
b)	In respect of		
	i)	Bank Guarantees given by /on behalf of the Entity	- Nil -
	ii)	Letter of credit opened by Bank on behalf of the entity	6,79,27,350
	iii)	Bills discounted with banks	- Nil -
c)	Disputed demands in respect of		
	i)	Income –tax	58,36,245
	ii)	Sales tax	- Nil -
	iii)	Municipal Taxes	- Nil -
d)	In respect of claims from parties for non-execution of orders, but contested by the Entity		- Nil -

2. CAPITAL COMMITMENTS

Estimated Value of contracts remaining to be executed on capital account and not provided for (net of advances)		
a)	Construction of Building	- Nil -
b)	Other Assets	-Nil -

3. LEASE OBLIGATIONS

Future obligations for rentals under finance lease arrangements for plant and machinery amount to Rs.Nil	- Nil -

4. CURRENTS ASSETS, LOANS AND ADVANCES

In the opinion of the Institute, the current assets, loans and advances have a value on realization in the ordinary course of business, equal at least to the aggregate amount shown in the Balance Sheet.

5. TAXATION

In view of there being no taxable income of the Institute under income tax Act, 1961, no provision for Income Tax has been considered necessary

WADIA INSTITUTE OF HIMALAYAN GEOLOGY,
33 GMS ROAD, DEHRADUN

6. FOREIGN CURRENCY TRANSACTIONS

a)	Value of Imports Calculated on C.I.F basis:		
	i)	Purchase of finished goods	- Nil -
	ii)	Raw Materials & Components (including in transit)	- Nil -
	iii)	Capital goods	- Nil -
	iv)	Stores, Spares and Consumables	- Nil -
b)	Expenditure in foreign currency		
	i)	Travel (for attending Seminar/Conference abroad)	- Nil -
	ii)	Remittances and Interest payment to Financial Institutions / Banks in Foreign Currency	- Nil -
	iii)	Other expenditure	
		Commission on Sales	- Nil -
		Legal and Professional Expenses	- Nil -
		Miscellaneous Expenses	- Nil -
c)	Earnings		
	i)	Value of Exports on FOB basis	- Nil -
	ii)	Grants for Projects	- Nil -

7. The payments to auditors during the F.Y. 2014 -15 is as follows:

Remuneration to auditors		
i)	As Auditors	29,070/-
	Taxation matters	- Nil -
	For Management Services	- Nil -
	For Certification	5,700/-
ii)	Others	- Nil -

8. Separate Financial Statements have been prepared for:

a)Wadia Institute of Himalayan Geology.
b) Contributory/ General Provident Fund.
c) Pension Fund.
d) Consolidated financial statement of projects sponsored by other Agencies.
e) Individual financial statements of Projects sponsored by other agencies.

9. Corresponding figures for the previous year have been regrouped / rearranged, wherever necessary.

10. Annexed Schedules & Annexures are an integral part of the Balance Sheet as on 31st March, 2015, Income and Expenditure Account and Receipt & Payment for the year ended on 31st March, 2015.

(Harish Chandra)	**(Dinesh Chandra)**	**(Prof. Anil K. Gupta)**
Finance & Accounts Officer	**Registrar**	**Director**

Date : 30th June, 2015
Place: Dehradun

WADIA INSTITUTE OF HIMALAYAN GEOLOGY, DEHRA DUN
PUBLICATIONS AVAILABLE FOR SALE

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(These volumes are the Proceedings of the Annual Seminars on Himalayan Geology organizsed by the Institute)

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Volume 1	(1971)	130.00	26.00
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Volume 3*	(1973)	70.00	-
Volume 4*	(1974)	115.00	50.00
Volume 5	(1975)	90.00	50.00
Volume 6	(1976)	110.00	50.00
Volume 7	(1977)	110.00	50.00
Volume 8(1)	(1978)	180.00	50.00
Volume 8(2)	(1978)	150.00	45.00
Volume 9(1)	(1979)	125.00	35.00
Volume 9(2)	(1979)	140.00	45.00
Volume 10	(1980)	160.00	35.00
Volume 11	(1981)	300.00	60.00
Volume 12	(1982)	235.00	47.00
Volume 13*	(1989)	1000.00	100.00
Volume 14* (in Hindi)	(1993)	600.00	-
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