Quarterly Newsletter
Wadia Institute of Himalayan Geology, Dehradun
(www.wihg.res.in)

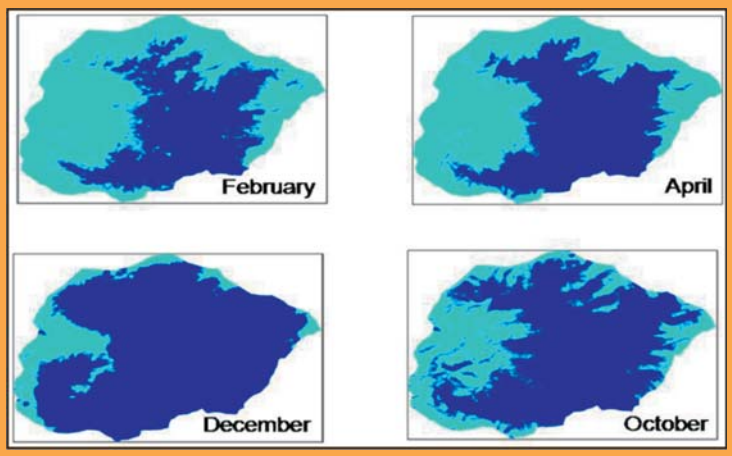
Bhugarbh Vani

Volume-5, No. 4
October to December, 2015

RESEARCH ACTIVITIES

Estimation of snow/glacier melt contribution in the upper part of the Beas River basin, Himachal Pradesh using conventional and SNOWMOD modelling approach:

Temperature index model (SNOWMOD) and conventional approaches were used to study the contribution of snow/glacier melt water in the Beas River at Manali. SNOWMOD model is designed to simulate daily stream flow for mountainous basin having contribution from snowmelt and rainfall. Hydrological, meteorological and snow cover area (SCA) of Beas River basin were analyzed for the period from 1996 to 2008. The information on SCA is determined from the MODIS satellite data. The hydrographs reveals that the rise in discharge during the pre-monsoon period (March-June) is mainly contributed by the melting of snow. The temperature-induced melting play a major role during the pre-monsoon period. Since precipitation is less



Snow cover map of Beas Basin upto Manali, Himachal Pradesh.

Announcement

Quaternary International—the journal of the International Quaternary Association (INQUA)—will publish a special issue on "Earthquakes and Active Tectonics of the Himalayan Convergent Boundary".

We invite you to submit a paper to *Quaternary International* special issue on Himalayan Active Tectonics. We seek research papers that address the following issues:

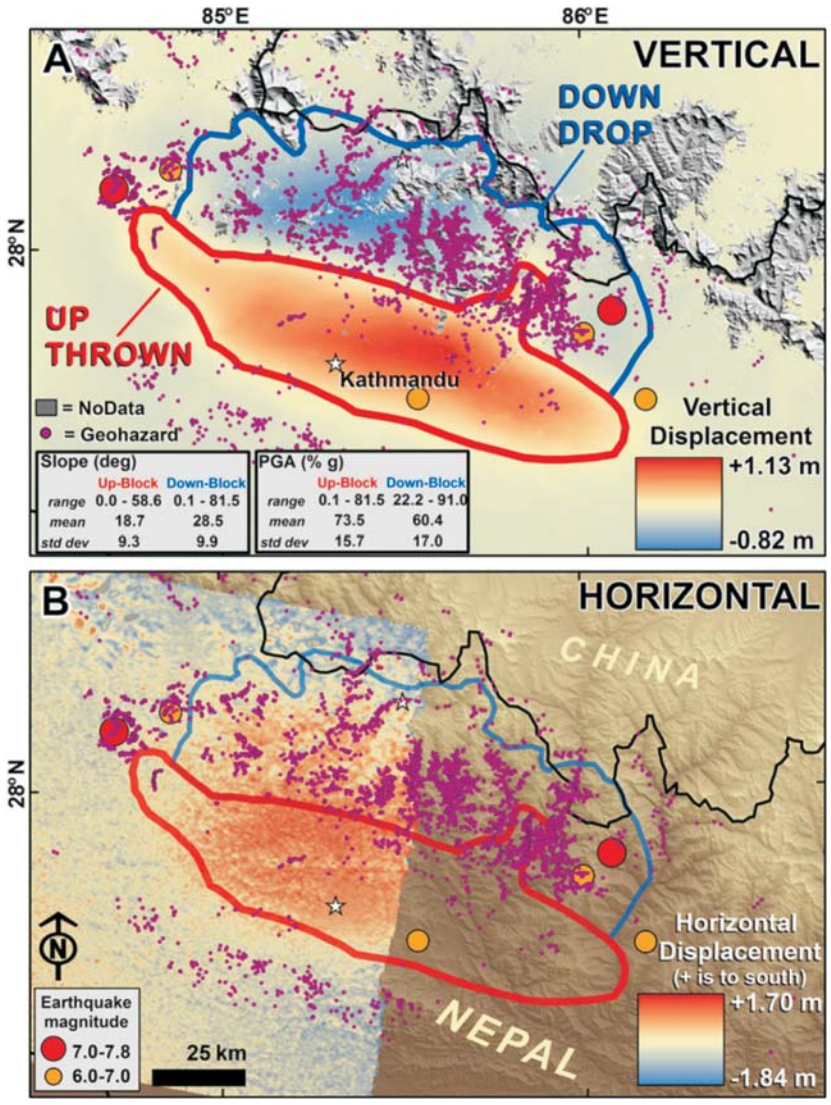
- Deformation rates at intermediate time scales through geomorphic markers (e.g. OSL, TL, SED)
- Characterization of strain pattern release at different timescales (e.g. InSar, GPS, seismological, and paleoseismological approaches).
- Exhumation – active structures.
- Evidence and timing of past earthquakes (Historical seismology, archaeoseismology, and paleoseismology).
- Models for active deformation across the Himalayan convergent boundary.
- Tectonic geomorphology and Neotectonics.
- Ground motion, seismic hazards and other topics in geophysics and engineering geology.
- And other related topics.

The guest editors for the special issue are R. Jayangondaperumal, T.M. Niemi, and N. Kumar.
The submission deadline for all manuscripts will be March 31, 2016, for expected publication at the end of 2016.

and rain events are mostly <20 mm for daily measurement and <50 mm for 10 daily, the increase in discharge is controlled by increase in air temperature. The river discharge is minimum during the winter months. It starts rising from the month of March and continue increasing trend up to September. In these month rise in discharge is mainly due snow and glacier melt during the pre-monsoon month. However, during the monsoon months (July, August and September) river is receiving contribution from the snow/glacier melt and rainfall derived runoff. Therefore river gain maximum discharge during this period, whereas river receives minimum discharge during winter season. The results show that the estimated annual average contribution of snow/glacier melt water in Beas River comes ~50% (using conventional approach) and ~54% using stream flow modeling technique (SNOWMOD). (*Jl. Water and Climate Change*, *6* (*4*): *880-890*)

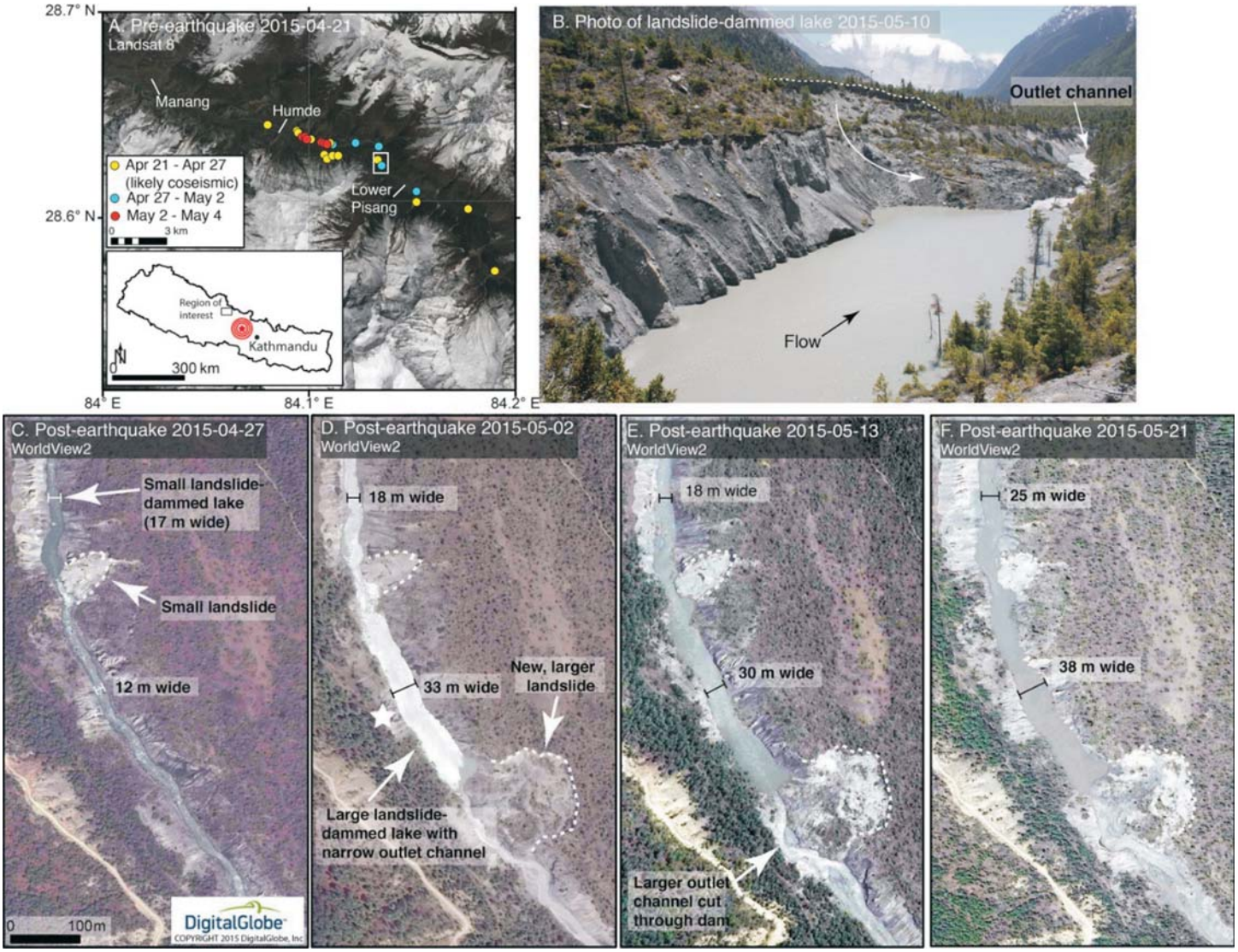
Geomorphic and geologic controls of geohazards induced by Nepal's 2015 Gorkha earthquake:

The Gorkha earthquake (M 7.8) on 25 April 2015 and later aftershocks struck South Asia, killing ~9,000 and damaging a large region. Supported by a large campaign of responsive satellite data acquisitions over the earthquake disaster zone, our team undertook a satellite image survey of the earthquakes' induced geohazards in Nepal and China and an assessment of the geomorphic, tectonic, and lithologic controls on quake-induced landslides. 4,312 co-seismic and post-seismic landslides



Landslide distribution relative to the Earth surface deformation field. (A) 4312 landslides (yellow dots) are concentrated mostly north of the hinge line between the downdropped block and uplifted block. Also shown are the epicenters of the main shock and five largest aftershocks. Vertical displacements are from the JAXA ALOS-2 ScanSAR interferogram (21 Feb 21 and 2 May 2015 scenes), which represent almost entirely vertical motion. ALOS-2 interferometry of the Gorkha earthquake and largest aftershock was recently described by Lindsey et al. (3). (B) Horizontal motion map based on azimuth shift measurements of the RADARSAT-2 XF acquisitions of 5 April 5 and 29 April 2015. Scale shows motion excluding outliers outside the mean ± 3σ. Values are positive for SSW azimuths >100 degrees relative to east (i.e., >S10W). Hence, both the upthrown and downdropped blocks shifted southward. Note that the areal coverage for the RADARSAT-2 scene is not identical to that of ALOS-2; areas on the eastern side of the scene have no data.

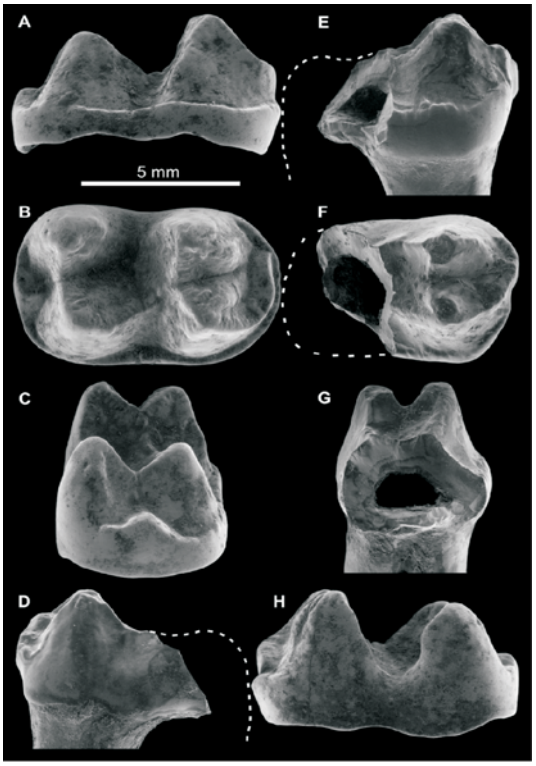
have been mapped. We also surveyed 491 glacier lakes for earthquake damage, but found only 9 landslide-impacted lakes and no visible satellite evidence of outbursts. Landslide densities correlate with slope, peak ground acceleration, surface downdrop, and specific metamorphic lithologies and large plutonic intrusions. (*Science Magazine, DOI: 10.1126/science.aac8353)*



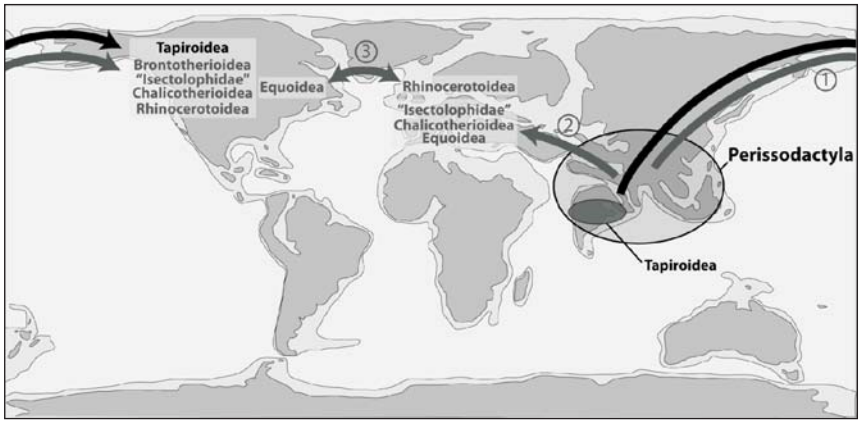
Landslide-dammed lake on the Marsyangdi River. Map and satellite imagery and ground photographs of landslides and landslide-dammed lakes on upper Marsyangdi River. (A) Map. White box locates (C), (D), (E), and (F). (B) Ground photograph (courtesy Mukhya Gotame, Manang villager) from 10 May 2015, showing the landslide-dammed lake looking south. White dashed line is the head scarp (note steep headwall) and curved arrow shows inferred flow path of the rotational slump. (C, D, E, and F) High-resolution WorldView-2 images of the river, showing delayed occurrence of the large landslide and lake formation. White star in D locates panel B. River widths are given at two locations.

First early Eocene tapiroid from India and its implication for paleobiogeographic origin of perissodactyls:

The occurrence of well-preserved fossils of cambaytheres, the sister group of perissodactyls, in the Cambay Shale Formation, western India around or before the time of collision with Asia suggests that the mammalian group Perissodactyla may have originated on the Indian Plate during its final drift towards Asia. This hypothesis is reinforced by the find of two teeth of the first early Eocene tapiromorph Perissodactyla from the same horizon and site (c. 54.5 Ma) in western India, which are allocated to a new genus and species, *Vastanolophus holbrooki*. The new fossils exhibit plesiomorphic characters typical of the paraphyletic "Isectolophidae," such as small size and weak lophodonty. However, the weaker hypoconulid and low paralophid, higher cusps, lower cristid obliqua, and the lingual opening of the talonid are found in Helaletidae, the most primitive tapiroid family. *V. holbrooki*, gen. et sp. nov., may be the oldest and the most primitive tapiroid, suggesting that at least tapiroid perissodactyls originated on India. (*Palaeovertebrata, 39 (2), e5*)



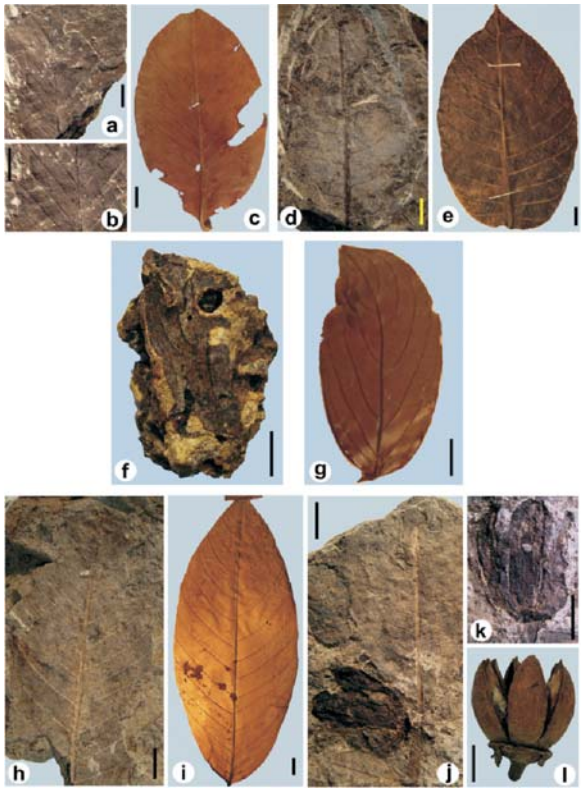
Vastanolophus holbrooki gen. et sp. nov. from the early Eocene of Vastan mine, India. A-C, H: right m1 in labial (A), occlusal (B), distal (C), and lingual (H) views. D-G: right fragmentary p4, in labial (E), occlusal (F), distal (G), and lingual (D) views.



Schematic map showing the geographic dispersal of the early perissodactyls. 1: dispersal via the Bering land bridge; 2: dispersal via land connections across the Turgai Strait and/or along the Tethysian shore; 3: dispersal via the Greenland land bridge (adapted from Ron Blakey, Eocene, http://www2.nau.edu/rcb7/050Marect.jpg).

Early Eocene macro and microflora from western India:

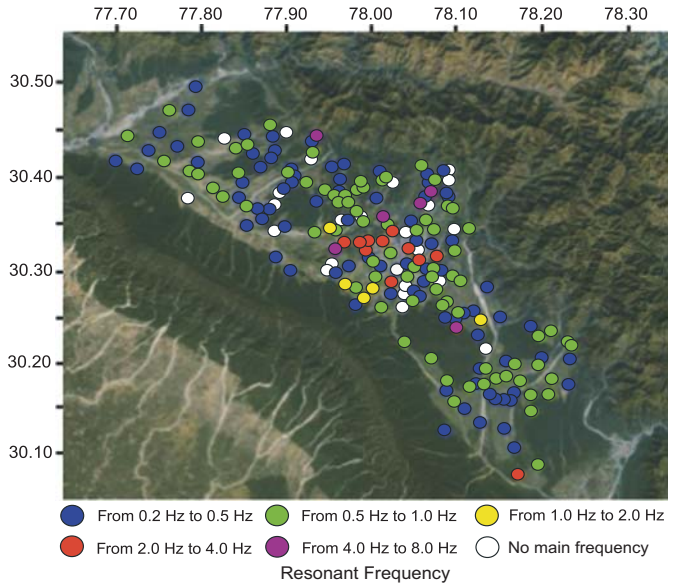
A diverse assemblage of plant macrofossils and the associated palynofloral elements are documented from the early Eocene subsurface beds of the Cambay Shale Formation exposed in an open cast Vastan lignite mine in the Surat District, western India. The fossils comprise leaf and fruit impressions, seeds, fruits, wood fragments, mangrove rooting structures, fungal thalli and spores, pteridophytic spores, and angiosperm pollen grains. Thirteen macrofossil species, including several morphotaxa, are represented by the families Calophyllaceae, Rutaceae, Anacardiaceae, Rubiaceae,Combretaceae, Lythraceae, Sapindaceae, Malvaceae, and Ebenaceae. The palynological assemblage representing fourteen taxa includes the new species, *Notothyrites undulatus*, *Callimothallus semicircularis*, and *Carallioipollenites integerrimoides*. Habitat and distribution of modern taxa comparable with the fossil assemblage from Vastan suggest a terrestrial lowland environment. The macrofossil taxa are indicative of mesophytic, mixed forest growing under tropical to subtropical climate with sufficient humidity. The occurrence of dipterocarp elements along with taxa such as *Swintonia*, *Pterospermum* and *Diospyros*, etc. seems to suggest the presence of a tropical rain forest in the vicinity of Vastan. (*Palaeoworld, 24* (*4*): *293-323*)



Fossil leaves and fruit compared with modern analogues (a, b) *Gardeniophyllum cambayum* n. gen. n. sp. fossil leaf; (c) *Gardenia latifolia*, modern leaf; d) *Anthocephalophyllum vastanicum* n. gen. n. sp. fossil leaf; (e) *Anthocephalus cadamba*, modern leaf; (f) *Combretum sahnii*, fossil leaf; (g) *Combretum decandrum*, modern leaf; (h, j) *Lagerstroemia patelii*, fossil leaves; (i) *Lagerstroemia flos-reginae*, modern leaf (k) *Lagerstroemiocarpon* sp. fossil fruit; (l) *Lagerstroemia flos-reginae*, modern fruit. Scale bars equal 10 mm.

Soil characteristics in Doon Valley by inversion of H/V spectral ratios from ambient noise measurements:

Past and recent observations have shown that the local site conditions significantly affect the behaviour of seismic waves and its potential to cause destructive earthquakes. Thus, seismic microzonation studies have become crucial for seismic hazard assessment, providing local soil characteristics that can help to evaluate the possible seismic effects. Among the different methods used for estimating the soil characteristics, the ones based on ambient noise measurements, such as the H/V

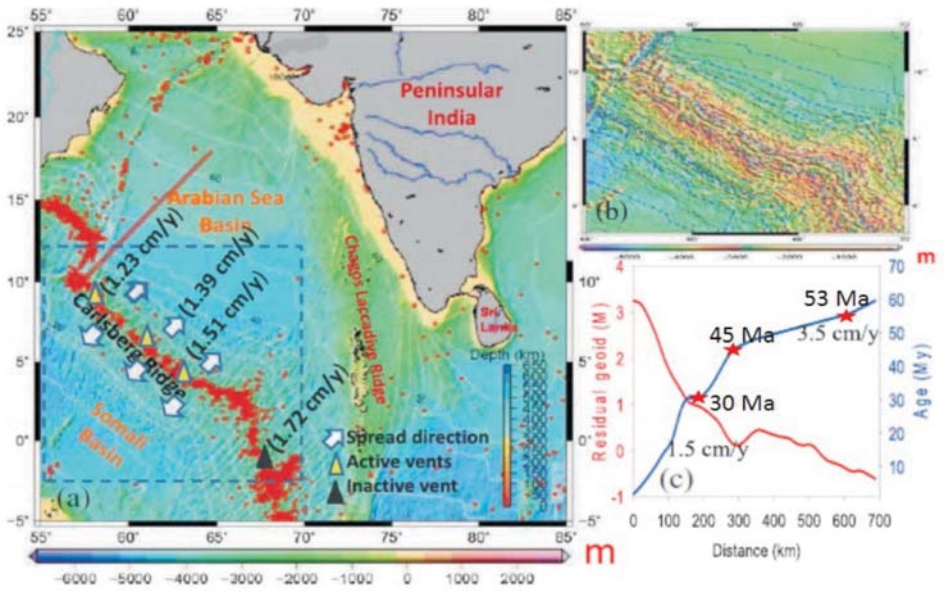


Map of fundamental resonant frequencies along the Doon Valley (Resonant frequencies appear grouped in different ranges marked with colors).

technique, become a cheap, non-invasive and successful way for evaluating the soil properties along a studied area. In this work, ambient noise measurements were taken at 240 sites around the Doon Valley, India, in order to characterize the sediment deposits. First, the H/V analysis has been carried out to estimate the resonant frequencies along the valley. Subsequently, some of this H/V results have been inverted, using the neighbourhood algorithm and the available geotechnical information, in order to provide an estimation of the S-wave velocity profiles at the studied sites. Using all these information, we have characterized the sedimentary deposits in different areas of the Doon Valley, providing the resonant frequency, the soil thickness, the mean S-wave velocity of the sediments, and the mean S-wave velocity in the uppermost 30 m. (*Soil Dynamics and Earthquake Engineering*, *77*:*309-320*)

Lithospheric basal heat flux and upper mantle thermal instabilities as drivers of the Indian Plate:

Considering the geodynamic evolution of the Indian Plate, there are two intriguing issues that related with its movement prior to the India-Eurasia continent-continent collision. First, what was the nature of heat anomaly source that drove the Indian plate at an astonishing speed of around 16 cm/yr before it ramps up over the Eurasian continent? Secondly, the onset of India-Eurasia collision; how various episodes of collision that imprinted as "obstructed plate movements" can be deciphered from the 70 Ma spreading rate history of the Mid-ocean ridges in the Northern Indian Ocean lithosphere. Observations based on satellite geodetic data, bathymetry and global Isochron illustrate that, the pre-collisional fast pace of the Indian Plate was powered by large scale vigorous convective thermal instabilities occurred around 290- 530 km in the upper mantle by the Kergulean mantle plume. However, the post collisional pace of the Indian plate was well regulated because of the prevailing non-plume advective-convective action beneath the Mid-Ocean Carlsberg Ridge. This advective-convective action is mainly driven by the basal temperature gradient between the lithosphere and the near lithospheric low viscose thin layer rather than the whole upper mantle. Thus in a scenario of uniform ridge push force the distinct spreading rate anomalies observed at 53, 45 and 30 Ma, and shown in Fig.1 (c) is indeed a proxy to understand the obstructed plate movement owing to the erstwhile India-Eurasia collision. (*Journal of Earth System Science, 124(8):1677-1691*)

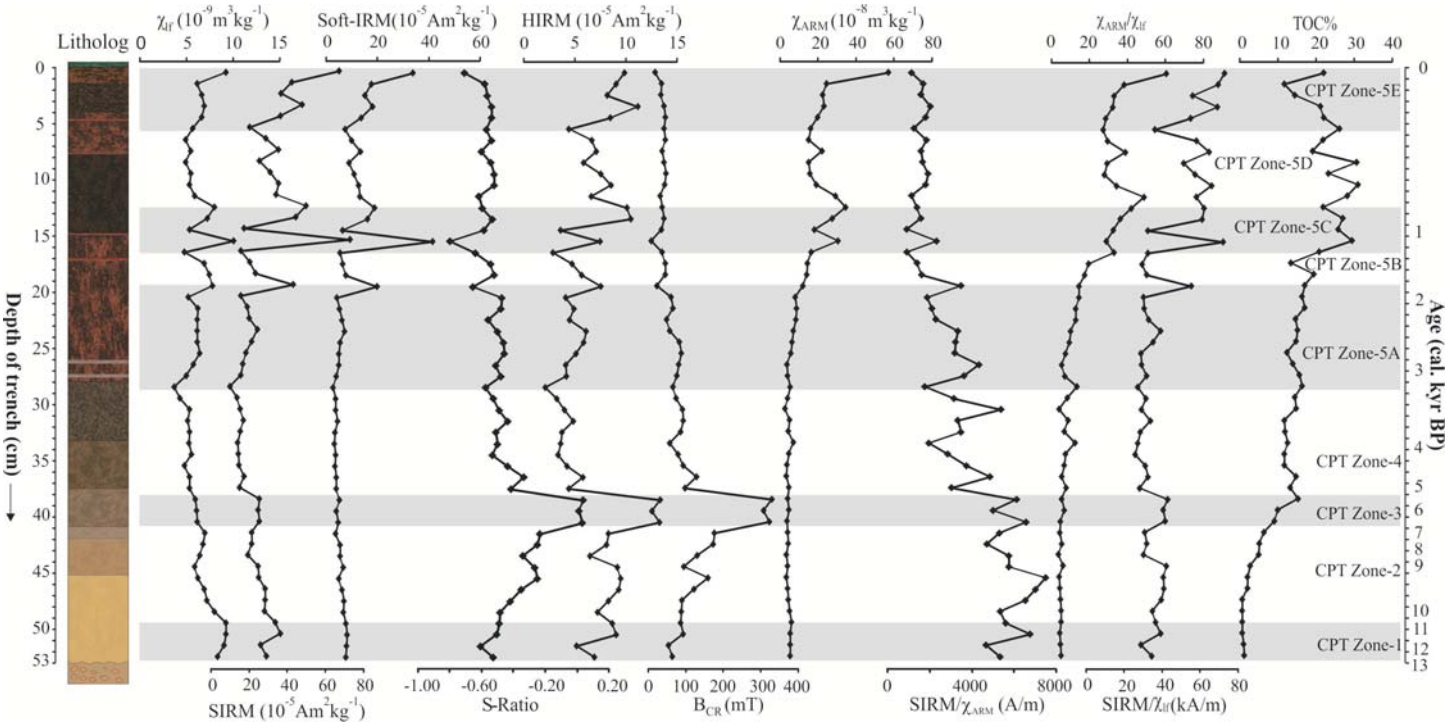


(a) the active divergent Mid-ocean plate boundary. (b) The spreading rift valley (c) Blue line shows the Plate spreading rate anomalies from the rift valley with respect to the Isochron age.

A 13,000 year record of environmental magnetic variations in the lake and peat deposits from Chandra valley, Lahaul: Implications to Holocene monsoonal variability in the NW Himalaya:

An ~13,000 year old record of in situ peat bog and lacustrine sediments from a post glacial lake in the Chandra valley of the Lahaul Himalaya is studied to generate the record of environmental magnetic signatures in response to Indian summer monsoon (ISM) variability in the NW Himalaya. The chronology of studied Chandra Peat Trench (CPT) profile is based on 9 AMS ^{14}C calibrated dates (cal yr BP). The piece-wise linear regression analysis of age-depth model indicates non-linear sedimentation with higher rates from ~4142 cal yr BP to the Present and lower accumulation during ~12,880-4142 cal yr BP. The mineral magnetism showed three dominant assemblages of magnetic minerals with varying concentrations in peat-lake sediment sequence i.e. (1) mixed ferri- and antiferromagnetic minerals between ~12,880 and 11,019 cal yr BP, (2) dominant antiferromagnetic mineralogy from ~11,019 to 3172 cal yr BP, and (3) significantly increased concentrations of mixed ferri-

and antiferromagnetic minerals from ~3172 cal yr BP to the Present with characteristically increased ferrimagnetic concentrations after ~2032 cal yr BP. The characteristic increase in antiferromagnetic mineral concentration accompanied by decreased ferrimagnetic concentration from ~10,398 to 5770 cal yr BP suggest possible oxidation of magnetite to hematite under warmer climate conditions and corresponds to increased ISM intensity during early to mid-Holocene warm-wet climate in the NW Himalaya. The distinctly increased concentration of antiferromagnetic minerals from ~6732 to 5770 cal yr BP indicates mid-Holocene climate optimum (HCO) in the Lahaul Himalaya. The strengthening and weakening of ISM recorded in environmental magnetic signatures during ~1260-852 cal yr BP (~690-1098 AD) and between ~852 and 239 cal yr BP (~1098-1711 AD) corresponds to Medieval Warm Period (MWP) and Little Ice Age (LIA) events, respectively. (*Palaeogeography, Palaeoclimatology, Palaeoecology, 440: 116-127*)



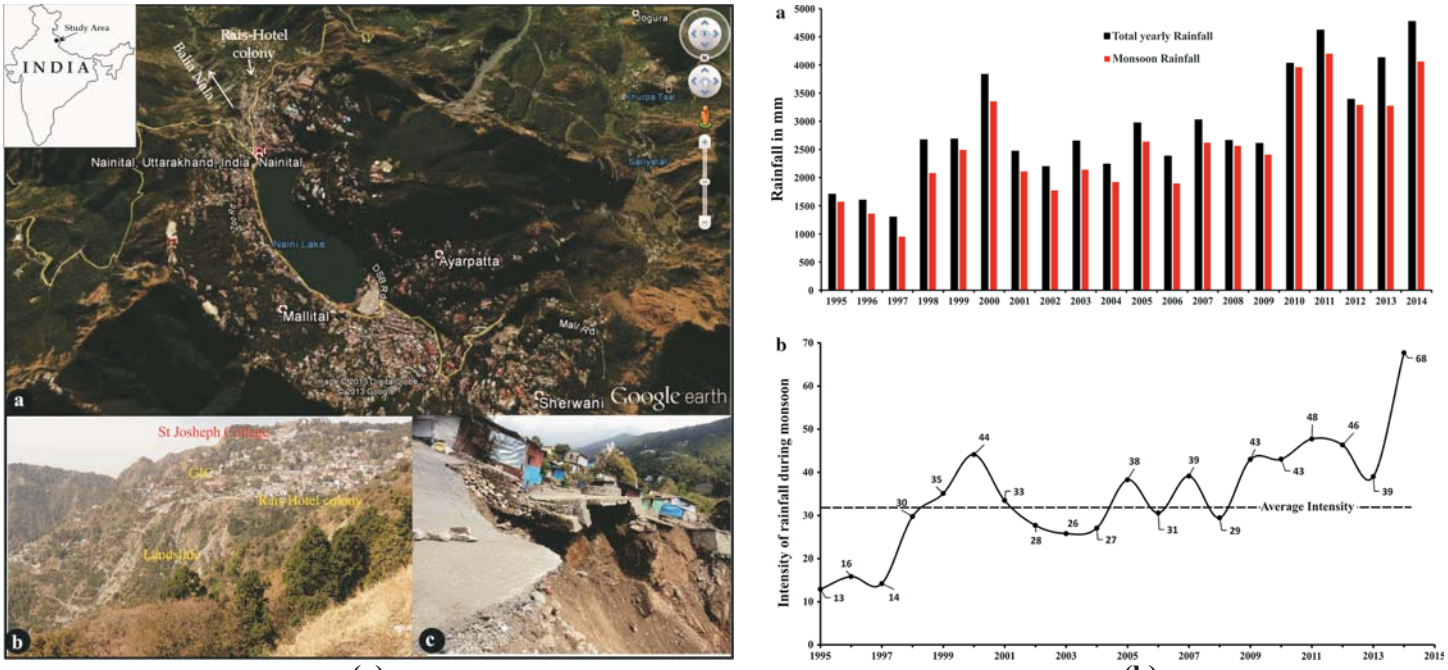
Environmental magnetic parameters plotted against litholog, depth, TOC%, and calibrated ages of CPT profile.

The 7.8 Magnitude Gorkha (Nepal) earthquake on 25th April 2015 gave us an opportunity to understand the GPS response to such Great earthquake at high sampling rate of 1 Hz. Our initial processing of data from WIHG, Dehradun station shows transient offsets in its position at all three components, rather than any static offsets. The 2D baseline change between an antenna pair during the time of Nepal Gorkha earthquake shows 5mm transient offset that last for a duration of around 34 minutes.

The transient fluctuation of baseline length in the event of a Great earthquake, although speaks little about plate kinematics; but significant in understanding the local site effects in hazard point of view.

Landslide Hazard in the Nainital township, Kumaun Himalaya, India-the case of Sept 2014 Balia Nala landslide:

Nainital township located in the Kumaun Lesser Himalaya is known to be vulnerable to landslides since past and it has been reported that half of the area of the township is covered with debris generated by landslide. A disastrous landslide in the Rais Hotel locality on the right side of the Balia Nala struck during Sept 2014 after the excessive rainfall. Geologically, the area dominantly comprises limestone with shale and slate which are highly crushed and weathered due to the presence of the Nainital Lake Fault that extends into Balia Nala as Balia Nala Fault. Ground Penetrating Radar (GPR) study depicts that these rocks are overlain by thin debris cover of the order of 5-10 m. The geotechnical studies confirm these rocks and the overlying soil as having very low strength. The landslide has triggered because of the excessive rainfall in the area. It has been observed that rainfall in the area has increased since 2010. An increase in more than 100 % intensity of rainfall during the monsoon from an average 33 mm per day (1995-2013) to 68 mm per day in 2014 is the main triggering factor for the initiation of 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. In order to prevent further sliding, 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. (*Natural Hazards*, *80* (*2*): *863-877*)

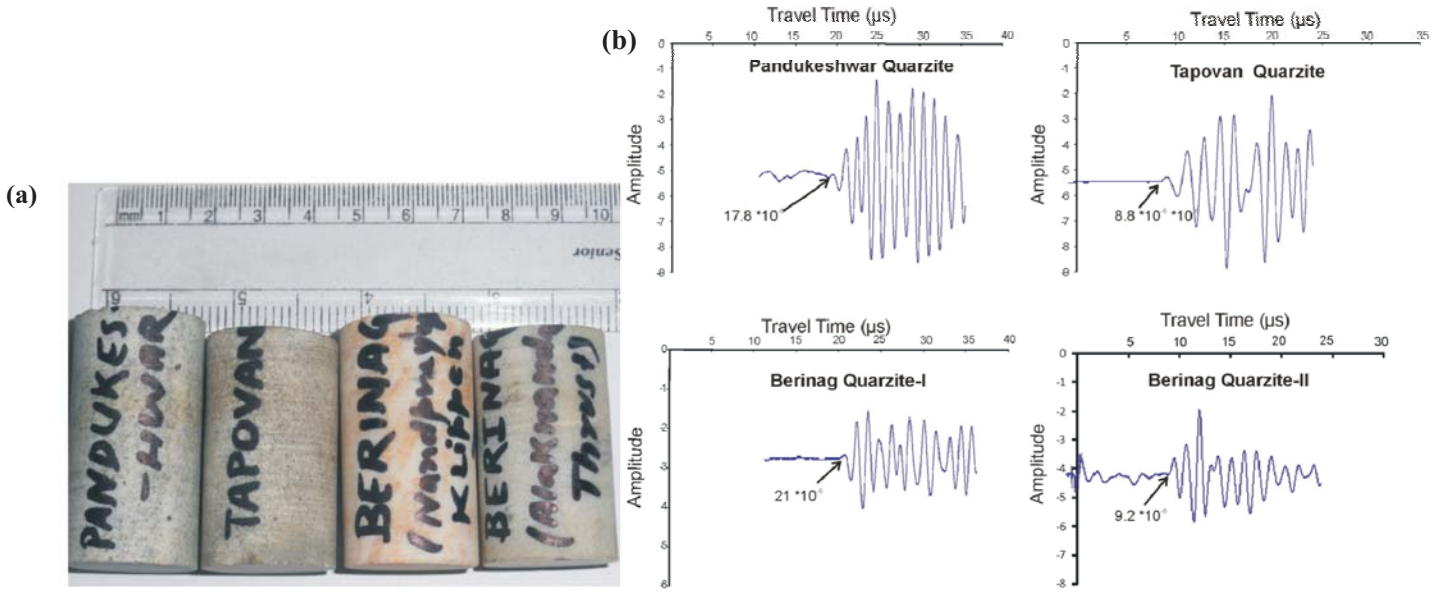


(a) (b)

(a) Location map of the area, a Google earth image of the study area and its surroundings. Note the location of the Balia Nala and the Rais Hotel colony locality towards the southern end of the Nainital Lake, b view of the Rais Hotel colony along with flat playground, Government Inter College (GIC) and St Stephen's College and c concrete footpath descending the slope that joins GIC and the Krishnapur located at the base of the slope. (b) a Average annual rainfall totals for the year 1995-2014 along with the rainfall during the monsoon period, i.e. during June-September and b intensity (total rainfall/number of rainy days) of rainfall during 1995-2014 for the monsoon period

Seismic properties of naturally deformed quartzites of the Alaknanda valley, Garhwal Himalaya, India:

The results of a study focusing on the influence of quartz microstructures on the seismic wave velocities in the Himalayan quartzites of the Garhwal Himalaya has been summarized. Quartzites consisting dominantly of quartz mineral were chosen for the present study so as to nullify the effect of other mineral constituents on the seismic velocity. Samples were collected from different tectonic settings of the Higher and Lesser Himalayas which are separated from one another by the major tectonic zone 'Main Central Thrust' (MCT). These are mainly Pandukeshwar quartzite collected from the hanging wall of MCT,



(a) Photograph of core samples of various quartzites. (b) Schematic diagram of the waveforms of test signals for the measurement of seismic velocities in various quartzites using P-wave transducers. Notice the vast difference in travel time although the length of core samples is more or less equal.

Tapovan quartzite collected from the MCT zone and Berinag quartzite collected from the Foot wall of MCT. The samples of Berinag quartzite were collected from near the klippen and the thrust, termed as Alaknanda Thrust. The vast differences in microstructures and associated seismic wave velocities have been noted in different quartzites. It has also been observed that quartzites of the MCT zone and Alaknanda Thrust have higher seismic velocities. This is because of their coarse-grained nature of the rocks as evidenced by the strong positive relation between seismic velocities and grain area. The coarsening is either due to the operation of grain boundary migration and grain area reduction process or high aspect ratio/shape preferred orientation. The quartzites located around Nandprayag Klippen have undergone static recrystallization and exhibit the lowest seismic wave velocities. (*Journal of Earth System Science*, *124*(*6*):*1159-1175*)

RESEARCH PUBLICATIONS

In SCI Journals

Ahluwalia, R.S., Rai, S.P., Jain, S.K., Dobhal, D.P. and Kumar, A. 2015. Estimation of snow/glacier melt contribution in the upper part of Beas Basin, Himachal Pradesh using conventional and SNOWMOD modelling approach. Journal of Water and Climate Change, 6(4): 880-890.

Gupta, V., Bhasin, R.K., Kaynia, A.M., Tandon, R.S. and Venkateshwarlu, B. 2015. Landslide Hazard in the Nainital township, Kumaun Himalaya, India - the case of Sept 2014 Balia Nala landslide. Natural Hazards, 80 (2): 863-877.

Kargel, J.S. et al. 2015. Geomorphic and geologic controls of geohazards induced by Nepal's 2015 Gorkha earthquake. Science Magazine, DOI: 10.1126/science.aac8353.

Kumar, Naresh and Khandelwal, D.D. 2015. Strong motion data analysis of the 4 April 2011 Western Nepal earthquake (M 5.7) and its implications to the seismic hazard in the Central Himalaya. Current Science, 109(10): 1822-1830.

Mundepi, A.K., Galiana-Merino, J.J., Asthana, A.K.L. and Rosa-Cintas, S. 2015. Soil Characteristics in Doon Valley (north west Himalaya, India) by inversion of H/V spectral ratios from ambient noise measurements. Soil Dynamics and Earthquake Engineering, 77: 309-320.

Singh, H., Prasad, M., Kumar, K. and Singh, S.K. 2015. Early Eocene macroflora and associated palynofossils from the Cambay Shale Formation, Western India: phytogeographic and palaeoclimatic implications. Palaeoworld, 24 (4): 293-323.

Rajesh, S. and Majumdar, T.J. 2015. Satellite derived geoids for the estimation of Lithospheric cooling and basal heat flux anomalies over the Northern Indian Ocean Lithosphere. Journal of Earth System Sciences, 124(8):1677.

Rawat, S., Gupta, Anil K., Srivastava, P., Sangode, S.J. and Nainwal, H.C. 2015. A 13,000 year record of environmental magnetic variations in the lake and peat deposits from Chandra valley, Lahaul: Implications to Holocene monsoonal variability in the NW Himalaya. Palaeogeography, Palaeoclimatology, Palaeoecology, 440, 116-127.

Smith, T., Sole, F., Missiaen, P., Rana, R.S., Kumar, K., Sahni, A. and Rose, K.D. 2015. First early Eocene tapiroid from India and its implication for the palaeobiogeographic origin of perissodactyls. Palaeovertebrata, 39 (2): e5.

Tandon, R.S., Gupta, V. and Sen, K. 2015. Seismic properties of naturally deformed quartzites of the Alaknanda valley, Garhwal Himalaya, India. Journal of Earth System Science, 124 (6): 1159-1175.

Books

Bhambri, R., Mehta, M., Dobhal, D.P. and Gupta, A.K. 2015. Glacier lake inventory of Uttarakhand. Special Publication of Wadia Institute of Himalayan Geology, Dehradun, 78p.

PARTICIPATION IN CONFERENCES/SEMINARS/WORKSHOPS/MEETINGS

Conferences

- Dr Rakesh Bhambri attended an International Conference on "Global environmental change in the Himalayas: Controversies, Impacts, Futures organised by Heidelberg University jointly with Free University Berlin and in partnership with TERI University during Nov. 6-8, 2015 at India Habitat Centre, New Delhi and presented a paper entitled:
  - Himalaya - Karakoram Glaciers Monitoring from Ground and Space
- Dr D.P. Dobhal attended an International Workshop on "Changes in Water Resource and Adaption Options in the Himalayan Basines" jointly organised by National Institute of Hydrology, Roorkee; Swedish Meteorological & Hydrological Institute (SMHI), Sweden; and Stockholm Environmental Institute (SEI), Sweden, during Nov. 16-17, 2015 at NIH, Roorkee.

- Dr P.S. Negi attended a Conference on "Environmental Pollution", organised by *Prayas* and *Lokbhari* (NGOs) at Kashipur, Nainital on Nov. 29, 2015 and presented a talk entitled:
  - Environmental Pollution in the Himalaya
- Dr D.P. Dobhal attended regional brain storming session on 36th IGC: "A Unique Opportunity for Advancement in Geosciences" organised by Working Office cum Secretariat for 36th IGC, Delhi and Regional IGC Cell, GSI, Northern Region, Lucknow, during Dec. 03-04, 2015.
- Dr D.P. Dobhal participated in "India-ICIMOD Week" organised jointly by Ministry of Environment, Forest and Climate change (MEFCC) and ICIMOD, Nepal during Dec. 14-15, 2015 at Indira Paryavaran Bhavan, New Delhi, as one of the panellist for the special technical session -4 "Changing Atmosphere and Cryosphere- Impact and Response".
- Dr Naresh Kumar attended the "XVIIIth International Conference of International Academy of Physical Sciences (CONIAPS XVIII) on Recent Trends in Physical Sciences" during Dec. 22-24, 2015 at Allahabad University, Allahabad.
- Drs Ajay Pal, S.K. Parcha, Sh Prakasam and Sh Abhmanyu Yadav participated in the Vth Bhartiya Vigyan Sammelan (IISF) Mega Science Expo - 2015 at IIT Delhi.

Colloquium

- Drs Meera Tiwari, S.K. Parcha and Rajita Shukla attended XV ICMS during Dec.17-19, 2015 at P.G. Department of Geology, Institute of Science, Aurangabad and presented following papers:
  - Sponge larvae in Chert-phosphorite Member of Tal Formation, Lesser Himalaya, India: a new tool to search evolution of metazoan life. (Meera Tiwari, Rajita Shukla and Harshita Joshi)
  - Cyanobacteria from the Cherts of Birmania Basin, Western Rajasthan. (Rajita Shukla and Meera Tiwari)
  - Biostratigraphy and biogeography of the Agnostids from the Cambrian successions of the Zanskar basin, Ladakh Himalaya, India (S.K. Parcha and S. Pandey)

Meetings

- Dr Vikram Gupta attended a meeting at National Disaster Management Authority (NDMA), New Delhi on data sharing for creation of a National Data Repository on landslide investigations/studies carried out by the Stakeholders on Oct. 08, 2015.
- Dr Ajay Paul attended a meeting on "How can we make Dehradun a SMART city" at MDDA Dehradun on Oct. 26, 2015.
- Dr Rajeev Saran Ahluwalia attended "Himalayan River basins: Hydrology and Glacial regimes" at National Institute of Hydrology, Roorkee on Nov. 5, 2015.
- Dr Vikram Gupta attended first meeting of National Green Tribunal (NGT) at Himachal Pradesh Secretariat, Shimla on Nov. 26, 2015 and second meeting at Himachal Bhawan, New Delhi on Dec.15, 2015 to look into the future construction activities in the Shimla township.
- Dr Sushil Kumar attended a meeting on "Earthquake precursor related information for State of Uttarakhand" at Uttarakhand Secretariate, Dehradun on Dec. 01, 2015.
- Dr Vikram Gupta and Monika Wadhwan attended project closing meeting of the research project titled "Earthquake Hazard and Risk Reduction on the Indian Subcontinent" at New Delhi on Dec. 02, 2015.
- Dr Rajesh Sharma attended the 'India International Science Festival' on Dec. 6, 2015 at IIT, Delhi and delivered a talk entitled:
  - Societal aspects of Regional Geoscientific Research
- Dr Suresh, N. attended the 2nd meeting of the expert committee for production of video serial "Geology and Geography of India" on Dec. 10, 2015 at Vigyan Prasar, New Delhi.
- Dr S.K. Bhartarya attended Working Group meeting of National Institute of Hydrology at Roorkee during Dec. 8-9, 2015.

FOREIGN VISIT

- Dr Bikramaditya visited National Taiwan University, Taipei, Taiwan as a Postdoctoral Fellow for six months during May 06 to Nov. 05, 2015.
- Dr A.K. Singh visited Department of Geosciences, National Taiwan University (NTU) Taiwan during Oct. 24 to Nov. 08, 2015.
- Dr Akshaya Verma attended 2nd Regional Training on "Glacio-hydrological modelling using the SPHY model" organised by ICIMOD, Nepal and Future Water, Netherlands during Dec. 14 -18, 2015 at ICIMOD, Kathmandu, Nepal.

TRAINING ATTENDED

- Sh Bhanu Pratap attended Basic Mountaineering Course-239 at NIM during September 15 - Oct. 12, 2015 to learn basic techniques of rock climbing, Snow and Ice craft.
- Sh J.S. Yadav participated in the short training course on "Modelling of Mountain Glacier Dynamics", organized by Earth and Climate Science, IISER, Pune during Sept. 23 - Oct. 04, 2015.
- Dr Dilip Kumar Yadav attended a training program on “Earthquake Resistance Construction Technology” during Sept. 28-30, 2015 at Uttarakhand Academy of Administration, Nainital.
- Sh Arun Prasanth attended a tTraining programme on 'Earthquake Hazard: Basic approaches, field investigations and modelling' held in Jammu, organised by Shri Mata Vaishno Devi University (SMVDU), Katra (J&K) and Indian Institute of Science Education & Research Kolkata during Nov. 10 -16, 2015.

FIELD VISITS

- Drs Rajeev Saran Ahluwalia, Reet Kamal Tiwari, Mohit Singhal and Suresh Sahni carried out glaciological field work in Chandra Bhaga River basin of Lahual & Spiti, H.P. A number of snow/ice samples from Samduratapu and Hamata Glacier and river water samples of Chandra and Bhaga rivers were collected during the field. Ground water samples were also collected for the Isotope ($\delta^{18}O$ and δD) study of the basin.
- Sh Kapil Kesarwani and P.K. Garg carried out field work on the Chorabari and Dokriani glaciers for AWS data collection and routine check-up/maintenance of AWSs observatories. During the field work, a new portable AWS was installed on the ablation zone of Chorabari Glacier to understand the effects of local meteorology on glacier ablation/accumulation.

Portable Automatic Weather Station installed at the Chorabari Glacier surface (3930 m a.s.l.). The station is equipped with the sensors of air temperature, relative humidity, surface temperature, wind speed and direction, atmospheric pressure, snow accumulation, incoming & outgoing both shortwave and long wave radiations.

- Prof A. K. Gupta, Drs M. Mehta, A. Verma, Sh K. Kesarwani and A.C. Gairola carried out a field work on the Chorabari Glacier, for seasonal observation, stake networking and AWS data collection.
- Drs A. Kumar, A. Verma and Sh A.A. Gokhale carried out field work in Dunagiri and Bangini glaciers for data collection, monitoring, site selection for AWS and closing the camp for winters. Two year time series of hydro-meteorological observations has been completed for both the glaciers as part of the fast track young scientist project.
- Drs R. Bhambri, S. Tiwari and Sh A. Misra visited Gangotri area to study glacial geomorphology, sSnout monitoring and hydrological observations of the area.
- Dr D.P. Dobhal, Sh T. Shukla, Ms S. Sundriyal, Sh J.S. Yadav and A. Misra carried out field work at Dokriani Glacier for survey of Ground penetrating Radar (GPR) at the ablation zone of glacier. The team successfully installed the Aethalometer at the

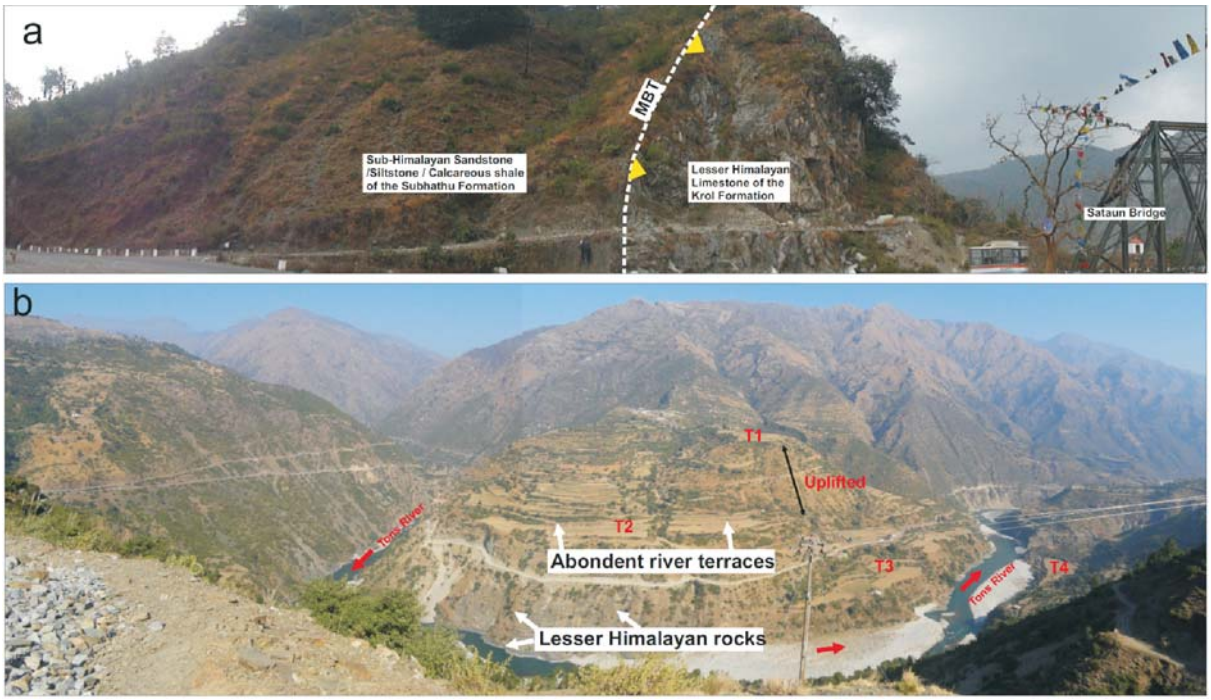
elevation of 3900 m asl to quantify the black carbon concentration at Dokriani Glacier. Apart from that study, we have also collected Melt water samples from sub-glacier, englacial and supraglacial channels of glacier were also collected to study the solute acquisition process of glacier.

- Dr P.S. Negi carried out field work in Gangotri Valley, Garhwal Himalaya and established an instrument to monitor atmospheric black carbon.
- Drs S.S. Bhakuni and P.S. Negi carried out field work in Sukhatal area of Nainital township for geological and bioengineering investigations.

Installing an instrument to monitor atmospheric black carbon in Gangotri Valley, Garhwal Himalaya.

Geological and bioengineering investigation in Sukhatal, Nainital.

- Dr D.K. Yadav carried out field work in seismic field stations in Garhwal Himalaya for digital data collection and necessary maintenance of seismic instruments at Uttarkashi (Bhatwari) and Garurganga seismic observatories.
- Drs S.S. Bhakuni and Paramjeet Singh carried out the field work in the Sub-Himalayan and Lesser Himalayan region along the Kala Amb-Nahan-Sataun-Chur traverse and collected sampled from various lithounits of the Siwalik Group, and Dagshai and Subhathu formations of the Sub-Himalaya and the Krol Formation of the Lesser Himalaya to constrain the geometry, kinematics, provenance and exhumation of thrust sheets using the Fission Track Thermochronology technique.



(a) Main Boundary Thrust (MBT) contact between the Sub-Himalayan Subathu calcareous rocks and Lesser Himalayan limestones; (b) Quaternary uplift and abundant river terraces (T1, T2, T3, T4) in the Tons River valley near Shillai, Himachal Pradesh.

- Dr S. Kumar and Sh R. Singh visited Jammu-Kishtwar for seismic data collection from six seismic observatories and checked the State of Health of instruments at Kiru, Kwar and Pakal Dul Projects around Kishtwar (J&K) area under CVPP Pvt. Ltd. consultancy project.
- Dr Vikram Gupta carried out field work in the Yamuna valley, Satluj valley, Mandakini valley and Nainital with the students and the scientific staff of the National Geotechnical Facility. In the Mandakini valley, fieldwork has been carried out under Department of Science and Technology (New Delhi) - Norwegian Geotechnical Institute (Oslo) (DST-NGI) Bilateral Collaborative programme on "Management of Catastrophic Natural Disaster in Uttarakhand (landslides and floods)" with team members drawn from various organisation like Prof Y.P. Sundriyal (HNB Garhwal University, Srinagar), Dr S.K. Mittal (CSIO, Chandigarh), Dr Bhoop Singh (DST, New Delhi), Dr R.K. Bhasin (NGI, Oslo), Dr Lloyd Tunbridge (NGI, Oslo) and Tomas Pabst (NGI, Oslo). Under this Bilateral program, Landslide Monitoring System comprising web camera and rain gauge have been installed opposite the Kunjethi village to monitor the vulnerable slopes of the village located in the Kali valley, Garhwal Himalaya.

View of the Landslide Monitoring System comprising web camera and rain gauge installed on the right bank of the Kali valley, opposite Kunjethi village.

WORKSHOPS/SEMINARS/SYMPOSIA HELD IN THE INSTITUTE

XXX Himalaya-Karakoram-Tibet Workshop:

The XXX Himalaya-Karakoram-Tibet Workshop was organized at the Wadia Institute of Himalayan Geology, Dehradun during October 06-08, 2015. Dr Krishna Kant, the Hon'ble Governor of Uttarakhand was the chief guest of the inaugural session. In the valedictory function Hon'ble Minister of Science & Technology and Earth Sciences, Govt. of India, was the Chief Guest. One day pre-workshop filed excursion to Mohand- Mussoorie section and four days post workshop field excursion tour to Rishikesh- Joshimath- Malari section were also a part of the event. In all, over 264 participants including 46 foreign participants presented their research work in the workshop. The participants were from IITs, reputed Universities and Research organisations across India. Leading workers from some of the globally recognised Universities like Stanford University- USA, University of Potsdam-Germany, University of Queensland- Australia, New Mexico State University-USA, Nagoya University- Japan, University Joseph Fourier- Grenoble France, University of Torino- Italy, University of Chicago-USA, University of Bern- Switzerland, Kyoto University-Japan etc. participated in this workshop. Total nine thematic technical sessions including tectonics, fluid-rock interaction, climate change, linkages between tectonics- climate and surface processes, sedimentary records, Earthquake geology and the natural resources, natural hazards and societal implications were organised. The subjects of societal importance were adequately focussed with two special sessions on Extreme events and Recent Nepal Earthquake. The state-of-the art, work done so far and gaps in the aforesaid themes were debated and discussed.

Following papers were presented by Institute Scientists:

- Changes in Glacier Facies and Behavior of Clean and Debris Covered Glaciers in Upper Indus Basin, Western Himalayas (A. Shukla, I. Ali and S.A. Romshoo)
- Present day kinematics of Himalayan Frontal Thrust in Garhwal and Himachal Himalaya through GPS measurements: Role of Geoid, topography and Gravitational Potential Energy (Rajesh S)

- Late Cenozoic Records of the River System of Northwestern Himalaya (Rohtash Kumar)

Posters Presented

- 3-D monitoring of glaciers in the parts of Chandra basin, Himachal Pradesh, India (Garg, P., Tiwari, R. K., and Shukla, A.)
- Assessing the debris cover dynamics and its relationship with glacier recession in Upper Indus basin, Western Himalaya (Ali, I. and Shukla, A.)
- Variation of stress pattern in different sectors of north-west Himalaya and its implication on regional tectonics (Dilip Kumar Yadav, Naresh Kumar and Devajit Hazarika)
- Mineral magnetic record of Late Pleistocene- Holocene environmental changes in lake and peat deposits of Lahaul, NW Himalaya (Suman Rawat)
- Numerical analysis of progressive Pawari landslide zone, district Kinnaur, Himachal Pradesh (Vipin Kumar, Vikram Gupta)
- Landslide susceptibility mapping of the Mussoorie township and its environs using GIS and Frequency Ratio method (Meenakshi Devi, Vikram Gupta)
- Engineering geological investigations for the assessment of rock fall hazards between Janki Chatti and Yamunotri Temple, Yamuna Valley, NW Himalaya (Imlirenla Jamir, Vikram Gupta)
- Slope instability and geotechnical characteristics of the slope materials along the Mansa Devi Hill bypass road, Haridwar Township (Ruchika S. Tandon, B. Venketeshwarlu, Vikram Gupta, Rajesh Sharma)
- Seismotectonics of the Garhwal Himalaya region of Central Seismic gap of NW Himalaya, India (Arun Prasath R, Ajay Paul and Sandeep Singh)

- Formation of Main Boundary Thrust (MBT) and its role in exhumation of the Amritpur ganite in Kumaon Himalaya (Paramjeet Singh)
- Post-glacial landform evolution in the middle Satluj River valley, India: Implications toward understanding the climate tectonic interactions (Shubhra Sharma)
- Fractal analysis of aftershock sequence of the 2015 Nepal earthquake (Sushil Kumar)
- Rapid sedimentation history of Rewalsar Lake, Lesser Himalaya, India during the last fifty years – Estimated using $^{137}C_s$ and ^{210}Pb dating techniques (Sudipta Sarkar)
- Evolutionary entities from the Krol-Tal Belt, Lesser Himalaya, India: A synoptic View (Rajita Shukla, Meera Tiwari and Harshita Joshi)
- Variability in boreal spring precipitation over the last millennium in cold arid western Himalaya, India (Ram R. Yadav, A.K. Yadav and Jayendra Singh)
- 1D velocity structure of the Garhwal-Kumaun Himalaya (Sanjay S. Negi, Ajay Paul and P. Mahesh)
- Mantle upwelling at the Neo-Tethyan spreading center was originated from a deep (~410km) and reduced source (Souvik Das and Barun K. Mukherjee)
- Continuous GPS time series analysis of MPGO Ghuttu, Central Himalaya, India (Param K. Gautam, Naresh Kumar, and Chandra P. Dabral)
- Holocene extreme hydrological events reconstructed using paleo-flood sequences in the middle Satluj valley, western Himalaya, India (Shubhra Sharma, A.D. Shukla, B.S. Marh and S.K. Bartarya)

MAC-USER Meeting: The MAC-USERS Meeting of SERB was organised at Wadia Institute of Himalayan Geology, Dehradun on November 17, 2015. The Chairman of the expert committee was Prof Kishan Lal.

PAC Meeting of NGF: The meeting of the Program Advisory Committee of National Geotechnical Facility was held on December 28, 2015 at NGF premises. Prof Gopal Ranjan, Chairman of the PAC and Dr Bhoop Singh, Head NRDMS, Dept. of Science and Technology, New Delhi were among those attended the meeting. Dr Rajesh Sharma, Project Director, presented the activities and development in NGF during last one year.

INVITED/INTERACTIVE LECTURES

- Dr A.K. Singh delivered lecture entitled "Tethyan ophiolites of Northeast India: Geodynamic and petrogenetic implications and mineralization" at the Institute of Earth Sciences, Academia Sinica, Taipei, Taiwan on Nov.01, 2015.
- Dr Sushil Kumar delivered a Key note address entitled: "About the Earthquake Hazard risk in the NW Himalaya, India" in the National Workshop on "Disaster Mitigation and Management Strategies" in the COER School of Management, Roorkee on Nov. 4, 2015.
- Dr Naresh Kumar delivered an invited talk on "Crustal velocity structure and seismotectonic of Kinnaur region of NW Himalaya: new constraints based on micro-earthquake activity" in the 18th International Conference of International Academy of Physical Sciences (CONIAPS XVIII) on Recent Trends in Physical Sciences held at University of Allahabad, Allahabad, during Dec. 22-24, 2015.
- Dr Vikram Gupta delivered a lecture titled "Landslide Hazard Assessment in the Mussoorie and Nainital townships, Garhwal Himalaya", in the closing meeting of the research project titled "Earthquake Hazard and Risk Reduction on the Indian Subcontinent" held at New Delhi on Dec., 02, 2015.

CELEBRATIONS

APJ Abdul Kalam birth Anniversary celebrations:

APJ Abdul Kalam 84th birth Anniversary celebration was organised in the Institute on 15 Oct., 2015. On this occasion Prof Mahavir Prasad, Vice Chancellor Uttarakhand Sanskrit University, Haridwar delivered a lecture. Institute scientists also shared their feelings about Dr APJ Abdul Kalam. A quiz was also organized on this occasion.

THESES SUBMITTED/ REGISTERED /AWARDED

- Kaushick Sen was awarded Ph.D. degree from University of Petroleum and Energy Studies, Dehradun under the supervision of Dr Barun Mukherjee (WIHG). The title of the thesis is "Formation and Tectonic Evolution of Zildat Ophiolitic Mélange, Indus Suture Zone, NW Himalaya, India."
- Arun Prasanth has registered for Ph.D. entitled "Seismotectonics of Garhwal Himalaya between Alaknanda and Yamuna Valleys" in IIT, Roorkee under the supervision of Dr Ajay Paul (WIHG) and Prof. Sandeep Singh, Professor, Department of Earth Sciences, IIT, Roorkee.
- S. Gupta has submitted Ph.D. thesis to HNB Garhwal University. The thesis entitled "Paleontological and geochemical study of Subathu succession of NW sub-Himalaya with reference to PETM and India-Asia collision" under the supervision of Dr K. Kumar (WIHG) and Dr R.S. Rana (HNBGU).

AWARDS/HONOURS

- Sh Bhanu Pratap received Best trainee award of the Basic Mountaineering Course-239 at Nehru Institute of Mountaineering, 15th Sept.-12th Oct. 2015.
- Dr Bikramaditya was awarded Postdoctoral Fellowship by the Ministry of Science and Technology, Taiwan, Republic of China, to work at National Taiwan University, Taipei, Taiwan for six months (May 2015-November 2015).

SUPERANNUATION

Dr Tejender Nath Jowhar, Scientist 'F', superannuated on 30th November 2015 from the Petrology and Geochemistry Group of the Institute. Dr Jowhar joined the Institute in 1986. In between he joined Department of Geology, University of Delhi as Reader (1997-1998). His field of specialization and research interests are in Igneous and Metamorphic Petrology, Himalayan Geology, and Computer Applications in Earth Sciences. During his tenure in the Institute Dr Jowhar took up systematic geological studies on several regions of the Himalaya, particularly Ladakh, Garhwal and Kumaun. His significant contributions in the field of Earth Sciences include reformulation of Alkali feldspar-muscovite geothermometry and its application to the Badrinath Crystalline Complex, Gangotri and Amritpur granite in the NW Himalaya; documentation of quantitative depth of emplacement and exhumation history of the Ladakh granite from the Ladakh batholith, Northwestern Himalaya; development of Petrological Data Base on Himalayan Granite, development of rapid X-ray diffraction method for determination of lattice parameters and structural state of alkali feldspars, and development of Several computer programs for mineralogical/Petrological and geothermobarometric calculations and their utilization for geothermobarometric investigations.

Mrs Sharda Sehgal, accountant, superannuated on 31st December, 2015 after thirty five years of long service in the institute. Mrs Sharda joined the Institute as LDC and during her tenure She worked in different capacity in different departments of the Institute. She was one of the most sincere, hardworking and devoted employee of the Institute.

WIHG family wishes a long, happy and prosperous life ahead to these members.

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