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

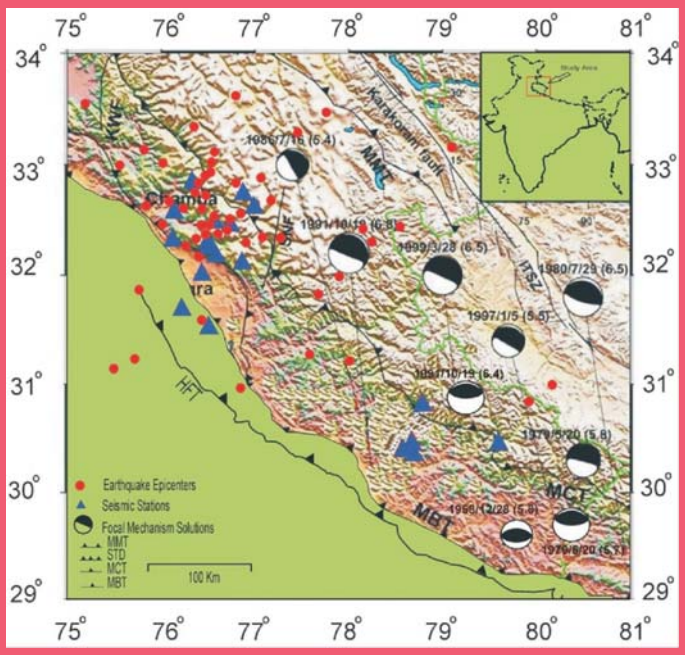
Bhugarbh Vani

Volume-6, No. 1
January to March, 2016

RESEARCH ACTIVITIES

Frequency dependent attenuation characteristics of coda waves in the Northwestern Himalayan (India) region:

Digital seismogram data of 82 earthquakes from the Northwestern Himalayan (India) region recorded at different stations during 2004−2006 were analyzed to study the seismic coda wave attenuation characteristic in this region. A total of 132 seismic observations from local earthquakes with a hypocentral distance <240 km and magnitude range of 1.2−4.9 were used to study the coda Q_C using the single isotropic scattering model. These earthquakes have been recorded at temporary 20 seismic stations installed in the Northwestern Himalaya (India) by the Institute. The Q_C values were estimated at 10 central frequencies: 1.5, 3, 5, 7, 9, 12, 16, 20, 24, and 28 Hz using starting lapse-times of 10, 20, 30, 40, 50, and 60 s and coda

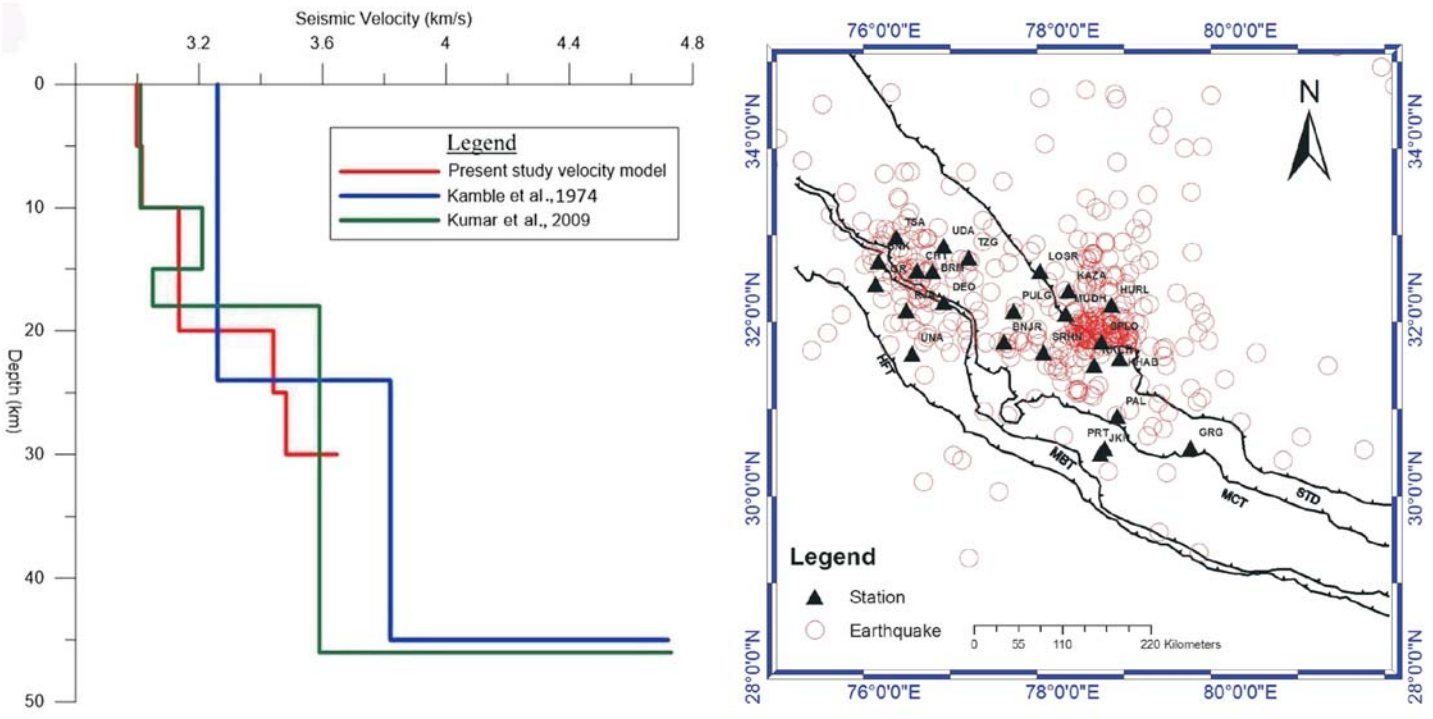


Blue triangles=Station locations; red circles=events ; HFT=Himalayan Frontal Thrust , MBT= Main Boundary Thrust; MCT=Main Central Thrust; STD=South Tibetan Detachment and MMT=Main Mantle Thrust. The focal mechanism of some strong earthquakes are shown in the figure, the date and magnitude of the events are given above the beach ball.

window-lengths of 10, 20, 30, 40, and 50 sec. The Q_C fits the frequency dependent power-law, $Q_C=Q_0f^n$. For 10 sec lapse time with a 10-sec coda window length $Q_C= 47.42f^{1.012}$ and for 50 sec lapse time with a 50 sec coda window length, $Q_C = 204.1f^{0.934}$. Q_0 (Q_C at 1 Hz) varied from ~47 for a 10 sec lapse time and 10 sec window length, to ~204 for a 50 sec lapse time and 50 sec window length. An average frequency dependent power law fit for the study region may be given as $Q_C = 116.716f^{0.9943}$. The exponent of the frequency dependence law *n* ranged from 1.08 to 0.9, which correlates well with values obtained in other seismically and tectonically active and heterogeneous regions of the world. In our study region, Q_C increases both with respect to lapse time and frequency, i.e., the attenuation decreases as the quality factor is inversely proportional to attenuation. The low Q_C values or high attenuation at lower frequencies and high Q_C values or low attenuation at higher frequencies suggest that the heterogeneity decreases with increasing depth in our study region. (*Journal of Asian Earth Sciences 117, 337-345*)

A preliminary one-dimensional crustal velocity model for Himachal Pradesh, India:

A preliminary one-dimensional (1D) velocity model for Himachal Pradesh, India has been developed by utilising the P and S wave travel time data. A very steady and narrow velocity model was obtained with travel time inversion, and a range of velocity models were tested with earthquake locations to derive the best fit velocity model. The 1D velocity model proposed for the study region has seven uniform layers with interfaces at depths of 0, 5, 10, 15, 20, 25 and 30 km with P wave velocity of 5.219, 5.314, 5.391, 5.392, 5.964, 6.071 and 6.073 km/s and S wave velocity of 2.998, 3.015, 3.134, 3.135, 3.441, 3.482 and 3.647 km/s, respectively. According to the proposed model, the Moho in this part of the Himalaya lies at 60 km depth on an average. For P and S waves, the station correction ranges from −0.88 to 1.50 and −0.58 to 3.59 s, respectively. This low variation in station residuals indicates small lateral velocity changes that confirm the accuracy and stability of the proposed 1D velocity model. Using the new derived 1D P & S wave velocity model (Fig. 4 a&b), the earthquake epicentres were relocated (Fig. 5) and we observe a shallow seismic activity in the region at <30 km depth that clearly describes the ongoing convergence of the India-Eurasia plates in the study region. This study also infers a new, highly active seismic window in the latitude range of 31.8 °N to 32.8 °N and longitude range of 76.8 °E to 78.8 °E in the study region across the Kaurik-Chango fault, a causative fault for the 1975 Kinnaur earthquake. (*Journal of Seismology 20, 305-318*)

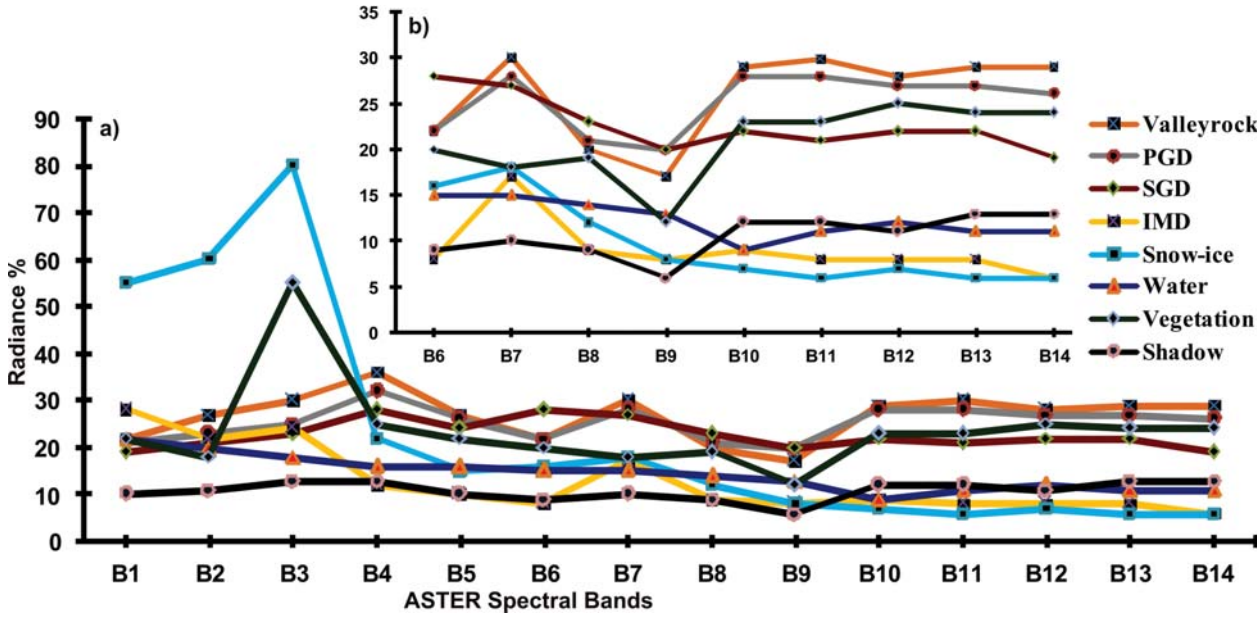


A B

A. a, b The minimum 1D velocity model of seven layers (red line) obtained with VELEST from travel time inversion of P and S wave arrival times and its comparison plot with the preliminary velocity of Kumar et al. 2009 (green line) and Kamble et al., 1974 (blue line). B. The Seismic network deployed and operated by Wadia institute of Himalayan Geology, Dehradun (WIHG) along with the seismicity plot in Himachal Pradesh, NW Himalaya, India. The triangles indicates the seismic stations and the hollow red circles indicates the earthquake epicentres.

A hierarchical knowledge-based classification for glacier terrain mapping: a case study from Kolahoi Glacier, Kashmir Himalaya:

A glacierized terrain comprises different land covers, and their mapping using satellite data is challenged by their spectral similarity. A hierarchical knowledge-based classification (HKBC) approach was proposed for differentiation of glacier terrain classes and mapping of glacier boundaries, using Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) imagery and Global Digital Elevation Model (GDEM). The methodology was tested over Kolahoi Glacier, Kashmir Himalaya. For the sequential extraction of various glacier terrain classes, several input layers were generated from the primary datasets by applying image-processing techniques. Noticeable differences in temperature and spectral response between supraglacial and periglacial debris facilitated the development of a thermal glacier mask and normalized-difference debris index, which together with slope enabled their differentiation. These and the other layers were then used in several discrete tests in HKBC, to map various glacier terrain classes. An ASTER visible near- infrared image and 42 field points were used to validate results. The proposed approach satisfactorily classified all the glacier terrain classes with an overall accuracy of 89%. The Z- test reveals that results obtained from HKBC are significantly (at 95% confidence level) better than those from a maximum likelihood classifier (MLC). Glacier boundaries obtained from HKBC were found to be plausibly better than those obtained from MLC and visual interpretation.

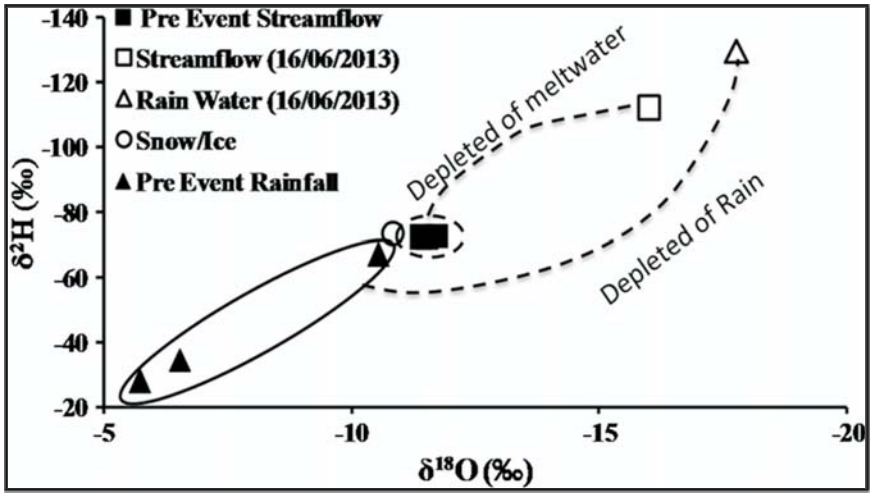


Spectral response curves derived from ASTER image; (b) zoomed-in view of spectral response curve from B6 to B14. Coloured lines represent the spectral behaviour of various classes. The *x*-axis represents different ASTER spectral bands (B1-B14). The *y*-axis denotes percentage spectral radiance. PGD: periglacial debris; SGD: supraglacial debris; IMD: ice-mixed debris.

Towards the understanding of the flash flood through isotope approach in Kedarnath valley in June 2013, Central Himalaya, India:

Three major hazards are associated with the Himalayan region, i.e. earthquakes, flash floods and landslides. During middle June 2013, Kedarnath valley in Rudraprayag district of Uttarakhand, India, was affected by catastrophic rainfall episode that caused massive loss of human lives and damage to the properties and livestock. In the present study, Isotope approach (δ18O and δD) is used to understand this catastrophic flash flood in Kedarnath valley. A field work was carried out before the flood from 21 May 2013 to 2 June 2014 to monitor and undertake the isotopic study for snow/ice melt runoff. In order to analyse the isotopic signatures of the Mandakini River, a sampling site was set up above the Shri Kedarnath Temple and collection of samples of river water, snow/ice melt water and rainfall started from 24 May 2013. Sample collection was continued by the watch and wards till 16 June 2013. However, they managed to escape themselves with such a terrible situation on 17 June 2013 morning from the base camp (near snout). Few samples including 16 June sample of rain and river flow were in good condition with appropriate labels which were brought for analysis by the field team when some communication was established in the valley after flash flood. Isotopic signatures of rainfall, snow/ice melt water and river water of Mandakini River were measured from 25 May 2013 to 16 June 2013, and these isotopic signatures are used to estimate the contribution of rainfall-derived runoff on flooding day. The result indicates that during the course of flood in Mandakini River, isotopic signature of river water was -15.97 %, whereas average isotopic signature of river before the flood shows -10.39 %. In the present study, a two-

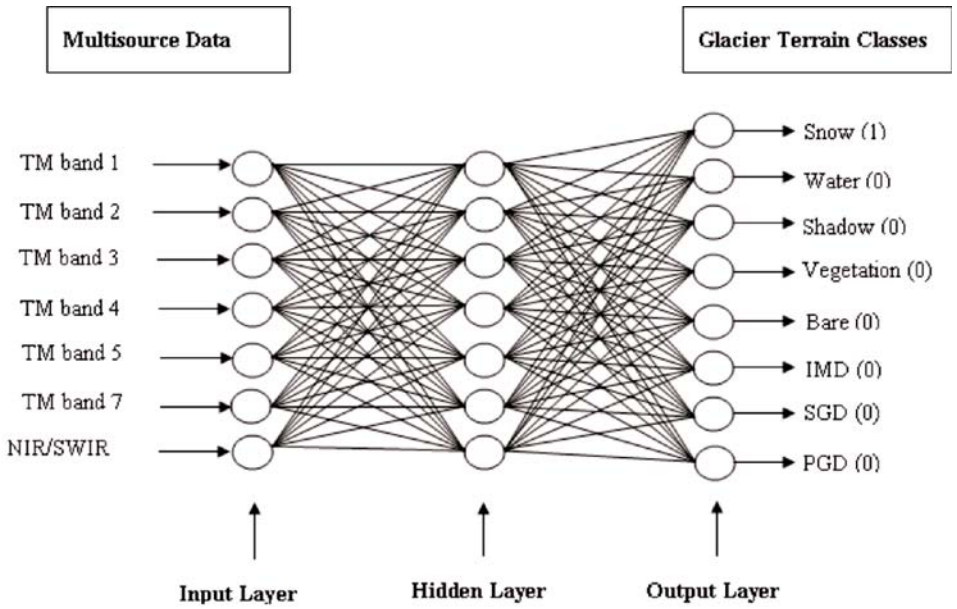
component mixed model was applied for the pre-event (flash flood) and syn-event in the Kedarnath valley as river flow was contributed only with two components, i.e. rainfall-derived runoff and snow/glacier melt runoff. By using the two-component mixed model, the contribution of rainfall-derived runoff is found to be 78 % and the contribution of snow/ice melt runoff is 22 % during the flash flood in Mandakini River surrounding the Shri Kedarnath Temple, Central Himalaya, India.



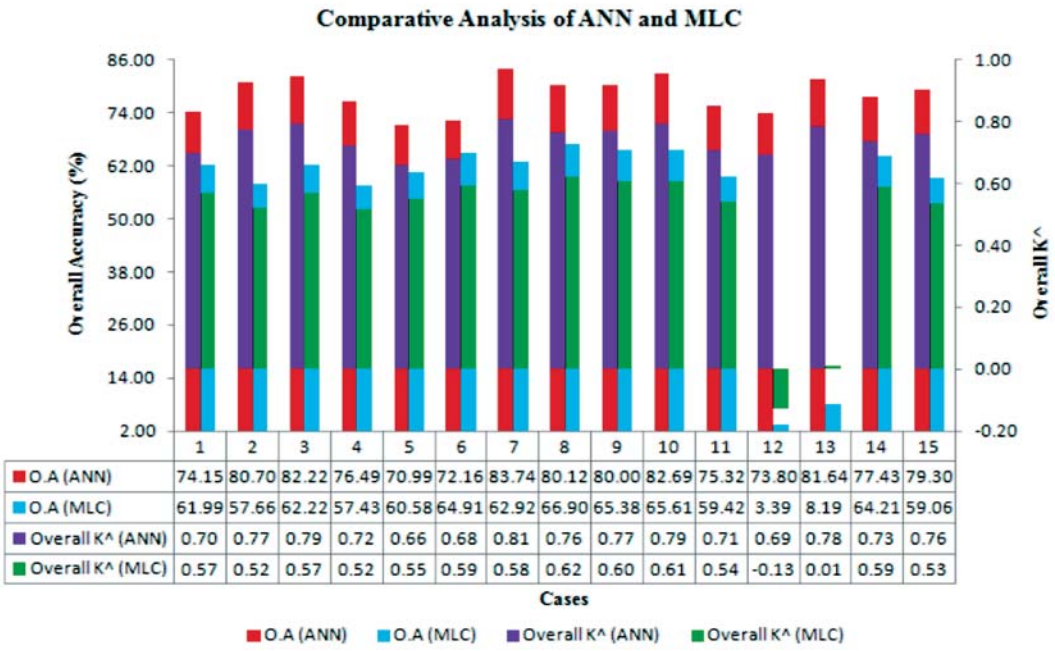
Contribution of snow/ice melt runoff and rainfall-derived runoff to Mandakani River at Chorabari base camp above Shri Kedarnath Temple.

Evaluation of Multisource Data for Glacier Terrain Mapping: A Neural Net Approach:

Spectrally similar nature of land covers in a glacierized terrain hampers their automated mapping from multispectral satellite data, which may be overcome by using multisource data. In the present study, an artificial neural network (ANN)-based information extraction approach was applied for mapping the Kolahoi glacier and adjoining areas, using Landsat TM (Thematic Mapper) data and several ancillary layers such as image transformations and topographic attributes. Results reveal that ANN (highest overall accuracy (OA): 83.74%) outperforms maximum likelihood classifier (highest OA: 66.90%) and the incorporation of ancillary data into the classification process significantly enhances the mapping accuracy (>9%), particularly the addition of Near Infrared Red/Short Wave Infrared (NIR/SWIR) data to the spectral data. A nine-band combination dataset (spectral data, slope, Red/NIR and decorrelation stretch) was found to be the best multisource dataset. Results of the *Z*-tests (at 95% confidence level) also corroborate and statistically validate the above findings.



An overview of neural network topology for multisource classification, Case 7: spectral data plus NIR/SWIR.

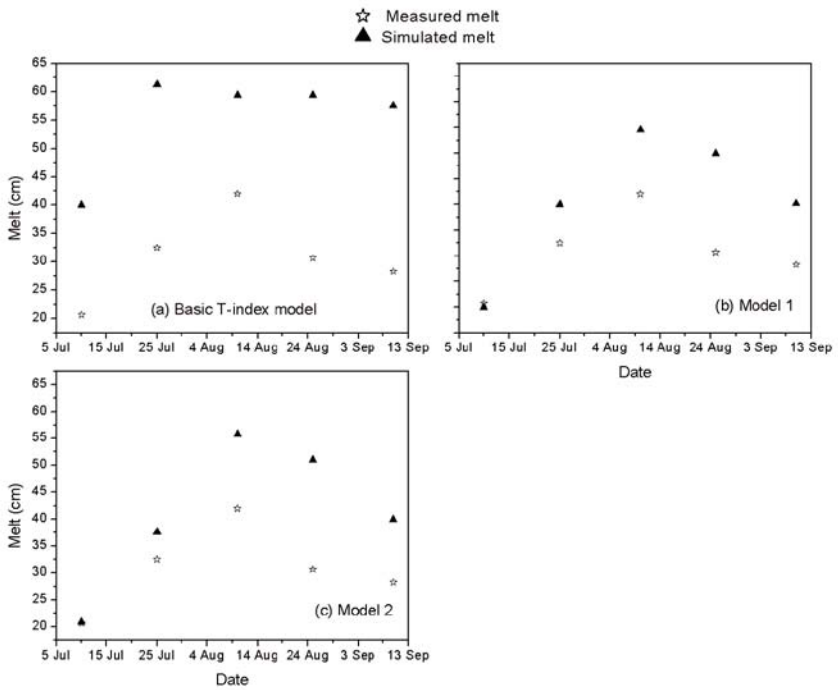


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
O.A (ANN)	74.15	80.70	82.22	76.49	70.99	72.16	83.74	80.12	80.00	82.69	75.32	73.80	81.64	77.43	79.30
O.A (MLC)	61.99	57.66	62.22	57.43	60.58	64.91	62.92	66.90	65.38	65.61	59.42	3.39	8.19	64.21	59.06
Overall K^ (ANN)	0.70	0.77	0.79	0.72	0.66	0.68	0.81	0.76	0.77	0.79	0.71	0.69	0.78	0.73	0.76
Overall K^ (MLC)	0.57	0.52	0.57	0.52	0.55	0.59	0.58	0.62	0.60	0.61	0.54	-0.13	0.01	0.59	0.53

Classification of overall accuracies and kappa coefficients using ANN and MLC.

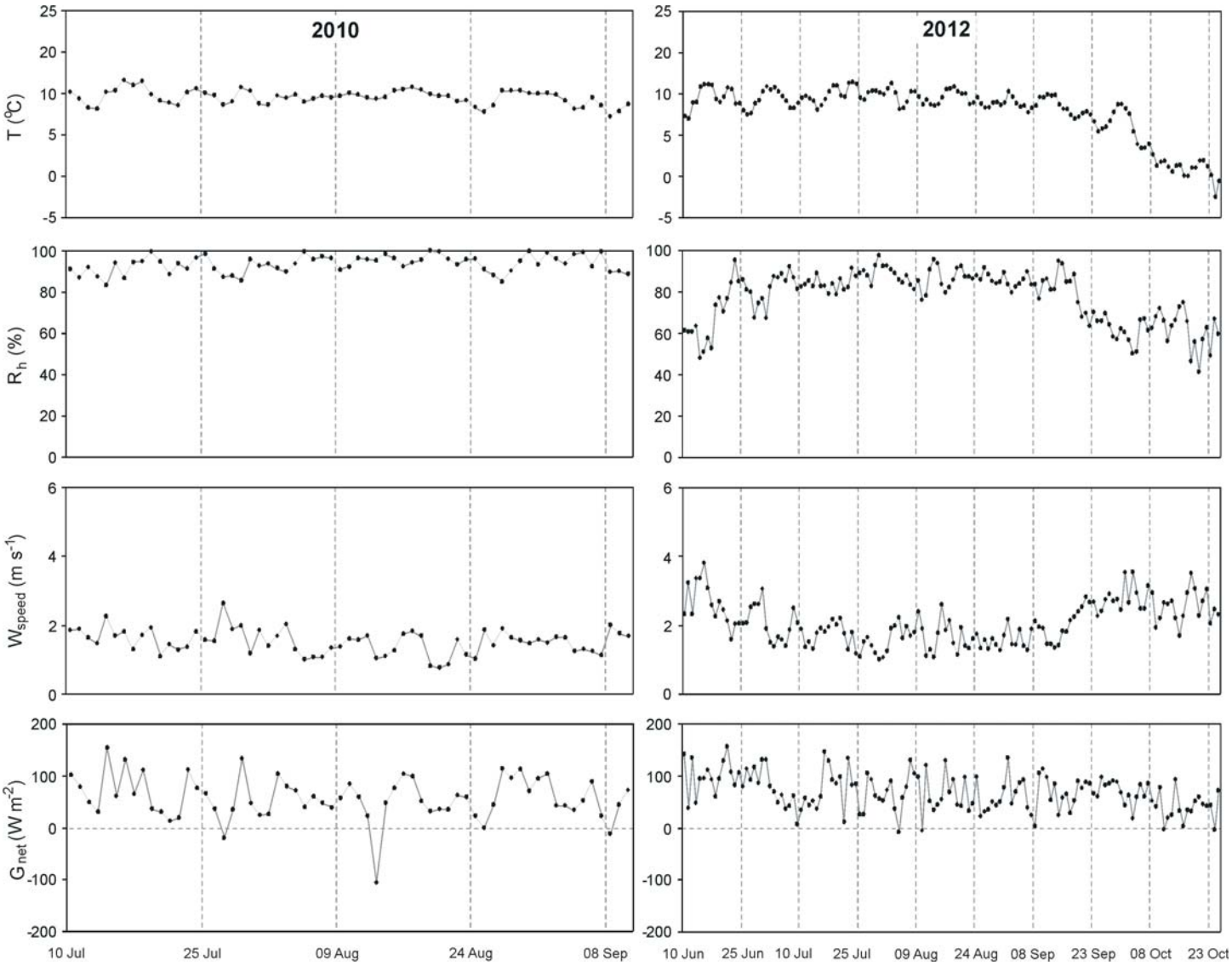
Extended T-index models for glacier surface melting: a case study from Chorabari Glacier, Central Himalaya:

The study on melting in Himalayan glaciers is important to assess the glacier response to climate change and to predict long-term availability of water resources. But the important concern is lack of continuous data measurement due to the harsh weather conditions and difficult accessibility. In this regard, modelling is a key tool to predict the data and to fulfil data gap. The approaches to compute melt range from simple temperature-index model to more sophisticated physically based energy balance models. Although different melt models have been developed worldwide, there is a lack of such type of work for Himalayan glaciers.



Time series of daily near-surface air temperature (T), relative humidity (Rh), wind speed (W_{speed}) and net radiation (G_{net}) observed at AWS site (3820 m a.s.l.) near the snout of Chorabari Glacier. The meteorological data are presented for years 2010 (July 10 to September 10) and 2012 (June 10 to October 25).

Two enhanced temperature-index (T-index) models are developed for Chorabari glacier by incorporating meteorological parameters viz. relative humidity, wind speed and net radiation. The models are an attempt to explore different climatic variables other than temperature affecting glacier surface melting. Weather data were recorded using an automatic weather station during the summers of 2010 (July 10 to September 10) and 2012 (June 10 to October 25). The modelled surface melt is validated against the measured point surface melting at the snout. Performance of the developed models is evaluated by comparing with basic temperature-index model and is quantified through different efficiency criteria. The results suggest that proposed models yield considerable improvement in surface melt simulation. Consequently, the study reveals that glacier surface melt depends not only on temperature but also on weather parameters viz. relative humidity, wind speed and net radiation play a significant role in glacier surface melting. This approach provides a major improvement on basic temperature-index method and offers an alternative to energy balance model.



Comparative plot of measured and modelled melting for the validating data set (July 10 to Sept 10, 2010).

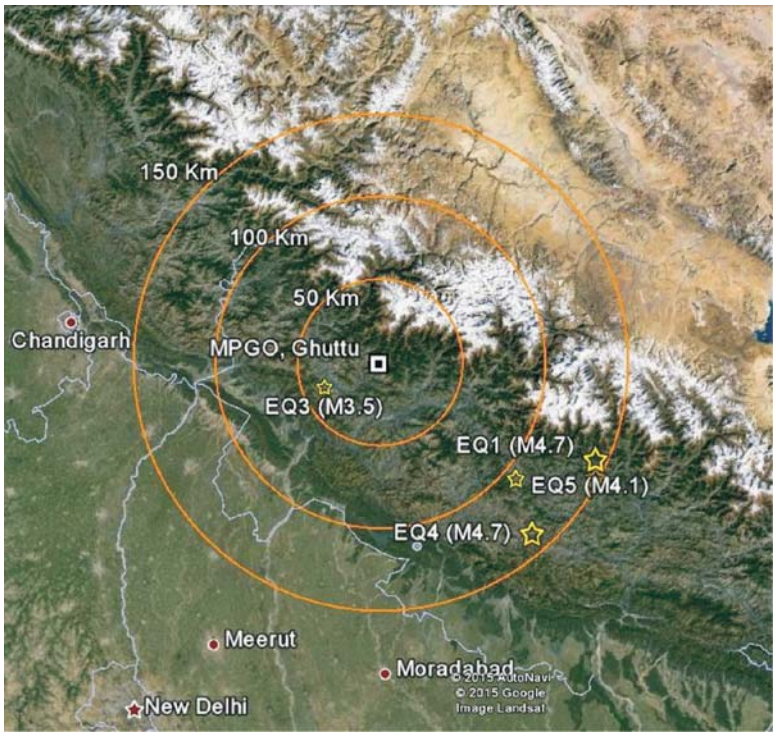
Applications of CRN dating technique with reference to Indian Himalaya- A compilation:

The Himalayan mountains preserve thousands of glaciers of widely varying properties, covering ~37000 km^2 and extending for >2500 km from east to west. The knowledge of Himalayan glacial history is of critical importance for understanding the palaeoclimatic reconstruction. However, a lack of absolute chronological control on the glacial landforms is a major problem to reach any definite conclusion on the phases of the Quaternary glaciation. The Surface Exposure Dating (SED) technique with Cosmogenic Radionuclide (CRN) has emerged as an important tool to date the glacial events. This paper reviews the basic principles and methods of SED technique and its applications in the context of erosional and glacial events in the

Himalaya. The SED method is suitable for not only temporal, but also spatial variations in the rates of geomorphic processes. The paper also highlights the existing gaps in the Himalayan glacial chronology. (*Himalayan Geology 37* (*1*), *54-66*)

Fractal dimension variability in ULF magnetic field with reference to local earthquakes at MPGO, Ghuttu:

Ultra low frequency (ULF) geomagnetic data recorded during 01 January, 2010 to 31 December, 2010 at multi-parametric geophysical observatory (30.53°N, 78.74°E) in Garhwal Himalaya region of Uttarakhand, India, are analysed. From the temporal variation of polarization ratio, presence of seismo-magnetic disturbances superposed upon background geomagnetic variations are inferred. Considering earthquake process as a SOC system based on flicker noise characteristics, fractal dimension for each day is estimated using two methods namely power spectral (FFT) method and Higuchi method. Variability in fractal dimension is studied in the background of local earthquakes (M≥3.5) within a zone of radius 150 km from observing station MPGO, Ghuttu. Fractal dimension variability indicates that average fractal dimension for first half of the year is increased as compared to average fractal dimension of second half of the year and there is gradual increase in the fractal dimension before earthquakes. It is also observed that during first half of the year, there is seismic activity within zone of 150 Km radius centred at around MPGO, Ghuttu. There are no earthquakes during the second half of the year. Gradual increase in the fractal dimension before earthquakes, observed elsewhere in the world, is considered precursory signature of seismo-electromagnetic field emissions.

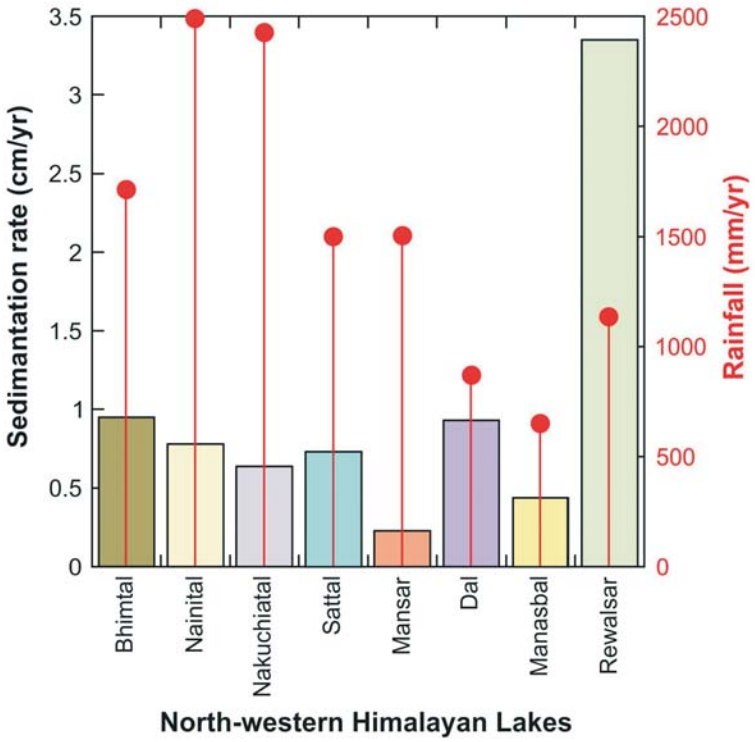


Location of MPGO, Ghuttu and epicentres of the earthquakes within a distance of 150 km from MPGO, Ghuttu. The figure is prepared using Google Earth.

Rapid sedimentation history of Rewalsar Lake, Lesser Himalaya, India during the last fifty years - Estimated using $^{137}C_S$ and ^{210}Pb dating techniques: A comparative study with other North-Western Himalayan Lakes:

The pristine Himalayan lakes are under threat due to higher sedimentation, ecological degradation and pollution, especially due to human interference. The higher sedimentation reduces the depth and size of these lakes. This study is aimed at understanding the last ~50 year's record of sedimentation and its shift in rates in the Rewalsar Lake, Himachal Pradesh, India. An effort has also been made to identify the natural, such as geological, esp. lithology and catchment slope and rainfall etc. and anthropogenic factors that could have governed the fluctuation in the sedimentation rates. A comparative study of some of the north-western Himalayan lakes has also been performed. The sedimentation rate of the Rewalsar Lake was measured on top 2 meter core samples using isotopes of ^{137}Cs and ^{210}Pb dating techniques. Our study reveals that the Rewalsar Lake experienced an average sedimentation rate of 3.35 cm/year during the last ~50 years which is the highest in comparison to the other lakes in the north-western Himalayan region. The 3.92 cm/year of rapid sedimentation rate was observed during *ca.* 1995 to 1963 AD

and 2.78 cm /year after 1995 AD. The study reveals that the enhanced human interference in the catchment area of the Rewalsar Lake is responsible for this rapid sedimentation.



Rainfall versus sedimentation rate of some of the north-western Himalayan lakes.

RESEARCH PUBLICATIONS

In SCI Journals

Ahluwalia, R.S., Rai, S.P., Gupta, A.K., Dobhal, D.P., Tiwari, R.K., Garg, P.K. and Kesarwani, K. 2016. Towards the understanding of the flash flood through isotope approach in Kedarnath valley in June 2013, Central Himalaya, India. Natural Hazards, 82(1), 321-332.

Bohra, A. 2016. Applications of CRN dating technique with reference to Indian Himalaya A Compilation. Himalayan Geology 37 (1), 54-66.

Kumar, S., Singh, P., Singh, Pitam, Biswal, S., Parija, M.P. 2016. Frequency dependent attenuation characteristics of coda waves in the Northwestern Himalayan (India) region, Journal of Asian Earth Sciences 117, 337-345.

Parija M. P., Kumar S., Biswal S., Kumar N. and Mishra S. K. 2016. A preliminary one-dimensional crustal velocity model for Himachal Pradesh, India. Journal of Seismology 20, 305-318.

Sarkar S., Prakasam, M., Banerji U. S. Bhushan R., Gaury P. K. and Meena N. K. 2016. Rapid sedimentation history of Rewalsar Lake, Lesser Himalaya, India during the last fifty years - Estimated using 137-CS and 210-Pb dating techniques: A comparative study with other North-Western Himalayan Lakes. Himalayan Geology 37(1), 1-7.

Books

Ali, I., Shukla, A. and Qadri, J. 2016. Monitoring glacial parameters in parts of Zanskar basin, Jammu and Kashmir. In: Geostatistical and Geospatial Approaches for the Characterization of Natural Resources in the Environment, (N. Janardhana Raju (eds.)), Springer publication, 893-897.

Shukla, A. and Qazi, B. 2016. Optimization of neural networks for multisource classification in a glaciated terrain. In: Geostatistical and Geospatial Approaches for the Characterization of Natural Resources in the Environment, (N. Janardhana Raju (eds.)), Springer publication, 755-759.

PARTICIPATION IN CONFERENCES/SEMINARS/WORKSHOPS/MEETINGS

Conferences

- Drs B.N. Tiwari, Rajesh Sharma and Ansuya Bhandari participated in the 103rd Indian Science Congress during January 3-7, 2016 at University of Mysore and presented following papers entitled:
  - Discovery of Hipparionine Dental Remains From Miocene Horizons of Central Kutch, Gujarat, Western India. (B.N. Tiwari and Ansuya Bhandari)
  - Trapped Basinal Fluids and Implications in Himalayan Sedimentary Sequences. (Rajesh Sharma)
  - Early Miocene fossils of the Dharmsala Group in Kangra Valley of Himachal Himalaya, significant geological revelations. (Ansuya Bhandari and B.N. Tiwari)
- Dr P.S. Negi attended "International Conference on Global Environmental Issues" at Vigyan Bhawan, New Delhi during March 4-6, 2016.
- Dr D.P. Dobhal participated in the IXth International Geographical Union (IGU) conference on "Land Use Change, Climate Extremes and Disaster Risk reduction", organised by Dept. of Geography Shaheed Bhagat Singh College, University of Delhi, during March 18 - 20, 2016.

Workshops

- Drs G. Philip, S.K. Bartarya and Vikram Gupta attended Brainstorming Workshop on High Resolution Landslide mapping at IIRS, Dehra Dun on March 04, 2016.
- Drs S.K. Bartarya and Vikram Gupta attended Consultation Workshop of States of the Himalayan Region 2016 under NMSHE during March 10-11, at New Delhi.

Meetings

- Dr Vikram Gupta attended meetings of National Green Tribunal (NGT) at Himachal Pradesh Secretariat, Shimla during January 15-16, and 22, 2016; February 15, 2016; March 22, 2016 to look into the future construction activities in the Shimla township.
- Dr Rajesh Sharma participated in the 55th Central Geological Programming Board meeting of GSI, during February 18-19, 2016 at New Delhi.
- Dr Vikram Gupta attended project monitoring committee meeting of the DST sponsored project at HNB Garhwal University, Srinagar during February 27-28, 2016.
- Drs D.P. Dobhal and Vikram Gupta attended a Task Force meeting "Protection Work in the Kedarnath area and Mandakini valley" at the office of Additional Secretary, Disaster Management, Uttarakhand Govt., Dehradun on March 29, 2016.

FIELD VISITS

- Dr Rajesh S. and P. K. R Gautam did field work on January 13, 2016 at MPGO Ghuttu observatory to repair and re-configure the GPS equipment. They also provided necessary training to the field staff at MPGO, Ghuttu to record GPS data from the observatory.
- Dr Ansuya Bhandari carried out a field work in Kutch during February 1 -15, 2016. Miocene horizons of the Outer & Trans Himalaya and Kutch are characterized by similar terrestrial faunal elements with imprints of global eustatic and Himalayan geodynamical changes in terms of presence of common exotics in the three regional assemblage. For clearer picture refined Miocene biostratigraphy of the three regions supported by adequate systematic fossil collection is obvious prerequisite. Field studies near Anjar in the Kutch show that there are two distinct fossiliferous horizons yielding fossils near Pasuda and Taper. These localities have enriched our local assemblages with better samples representing diversified mammals like *hipparians,* proboscideans, tragulids, suids, etc.

Field photographs showing recovered fossils in Kutch localities.

- Sh. Arun Prasath R. carried out field work at Chakrata, Nahan, Ghuttu, Adibadri and Tapovan for seismic data acquisition and monitoring the state of health of the sites.
- Dr Vikram Gupta carried out field work near the Uttarkashi township in the Bhagirathi valley during February 8-10, 2016 to look into the reactivation of Varunavat Parvat landslide and the landslide activities near the Bhatwari area.
- Dr Kapesa Lokho carried out field work to the Naga Hills in the Indo-Myanmar suture zone, Northeast Himalaya during February 26 to March 9, 2016 and collected rock samples from the flysch and molasse deposits of Palaeogene and Neogene sediments respectively for micropaleontological studies.

Molasse deposit of Neogene sediments in the Indo-Myanmar suture zone, NE Himalaya.

- Dr Kishor Kumar carried out 15 days field work in Tadkeshwar and other nearby open-cast lignite mines in the vicinity of Surat in western India for prospecting new horizons and sites and collecting early Eocene land vertebrate remains that occur in the lignite-bearing sub-surface beds of the Cambay Shale Formation (early Eocene). The new fossils collected from exposure surfaces comprise several fish, snake and mammal vertebrae, jaws, limb bones, and dentitions of varied vertebrates. Apart from the vertebrate fossils, several rather large and small seeds/fruits of plants and several fragments of *Teredolites*-infested fossil wood were also collected. From the younger horizons a few crab specimens were also collected. Around 500 kg of bulk samples of fossiliferous sandy clay were screen-washed in the field itself and about 15 kg of residue transported to the laboratory for sorting and recovery of smaller skeletal elements. A few test samples were also taken for miscellaneous studies.

Subsurface beds of the fossiliferous Cambay Shale Formation exposed in one of the open cast mines near Surat.

Well preserved edentulous jaw of a primate from the same beds.

Subsurface beds of the fossiliferous Cambay Shale Formation exposed in one of the open cast mines near Surat.

- Drs Rajesh Sharma and S.S. Bhakuni carried out field work in sulphide mineralized localities in Amba Khala in Sirmour Dist. (H.P.), and Chamri (H.P.) and Amtiyar gad in Tons river valley in Uttarakhand. The sulphide mineralisation is found localized in the shear zone. In Amba Kala sulphide mineralization occurs veins in slates and phyllites, is enriched in galena with subordinate chalcopyrite.
- Dr P.K.R Gautam carried out field work around Haridwar, Uttarakhand to locate suitable site for installation of a new broadband Seismograph.
- Dr Parveen Kumar carried out field work at Naddi, Tissa, Rewalsar and Kothi (Manali) during March 12 to19, 2016 for installation of new seismographs and accelerographs.
- Dr Devajit Hazarika visited 9 broadband seismological stations in Satluj valley for collecting earthquake data as well as for necessary maintenance and calibration of the seismograph station during March 26-30, 2016.
- Sh Rabindra Singh and Sh C. P. Dabral carried out field work during March 11 to 15, 2016 at Pithoragarh and Munsyari (Uttarakhand) to locate suitable sites for installation of New Broadband V-SAT Seismograph.
- Dr Sh Rabindra Singh and Sh Narender Singh carried out field work at Badshahi Thol (Tehri) for installation of Broadband V-SAT Seismograph.

INVITED/INTERACTIVE LECTURES

- Dr Gautam Rawat delivered an invited lecture on "Collision tectonic signature using Magnetotelluric investigation" in a workshop "Geodynamics of The Himalayan Arc: Knowledge update from April 25, 2015 Gorkha Nepal Earthquake" held during January 12-14, 2016 at MoES, Govt. of India, New Delhi.
- Dr D.P. Dobhal delivered an invited lecture on "Climate change impact on glaciers; Observation and Facts" in the Training Programme on "Climate Change: Vulnerabilities and Adaptation Strategies" for Scientists and Technologists, on February 09, 2016 at ICFRE, FRI Dehradun.
- Dr A. K. Singh delivered an invited lecture on "Ophiolites of the Indo-Myanmar orogenic belt, Northeast India: Petrogenesis and geodynamic implications" in the National Seminar "Shear zones & crustal blocks of southern India" held at Kerala University, Trivandrum during February 15-16, 2016.
- Dr Vikram Gupta delivered series of lectures in the University of Petroleum and Energy Studies (UPES), Dehradun on various aspects of Engineering Geology to the participants of L&T on March 12, 2016.

THESES AWARDED

- Shri Bhanu Pratap, was awarded the Ph.D. degree from University of Petroleum & Energy Studies, Dehradun, under supervision of Dr D.P. Dobhal and V.C. Tewari in Feb, 2016. The thesis entitled "Mass balance of Dokriani Glacier, Central Himalaya: A model in response to climate fluctuation and debris cover".

M.Sc. DISSERTATION

- Dr Rajesh Sharma supervised M.Sc. Dissertation work of Ms Prinyanka T., Central University Karnataka. January to March 2016. Title: 'SEM-EDX, Laser Micro Raman Spectroscopy and Fluid Inclusion Studies of the Chalk Hill, Salem District: Constraint for the origin of magnesite'.

AWARDS/HONOURS

- Sh Rakesh Singh received the Young Scientist Award in Xth Uttarakhand State Science & Technology Congress (USSTC), Earth Science discipline 2015-16, on February 12, 2016 organised by Uttarakhand State Council for Science & Technology (UCOST), The title of the poster was:
  - SWS measurements for monitoring stress level: Observations from local earthquakes in Chamoli region, Garhwal Himalaya. (Rakesh Singh and Ajay Paul)
- Dr Rajesh Sharma is selected as a Member of the Scientific Committee for the forthcoming 'VI Asian Current Research on Fluid Inclusions', scheduled to be held in November 2016 at I.I.T., Mumbai.

TRAINING PROVIDED

- Dr Gautam Rawat provided training to Project staff of MPGO observatory of Manipur University from January 16 to 20, 2016 regarding operation and initial data processing of Long period Magnetotellurics, Digital Fluxgate Magnetometer and ULF band Induction coil magnetometer.

SUPERANNUATION

Sh Satish Chandra Kothiyal, Senior Technical Officer, superannuated on January 31, 2016 after ~twenty seven years of service in Wadia Institute of Himalayan Geology. Sh Kothiyal joined the Institute as lab attendant in 1996 and worked in different labs during his service span.

WIHG family wishes him a long, happy and prosperous life.

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