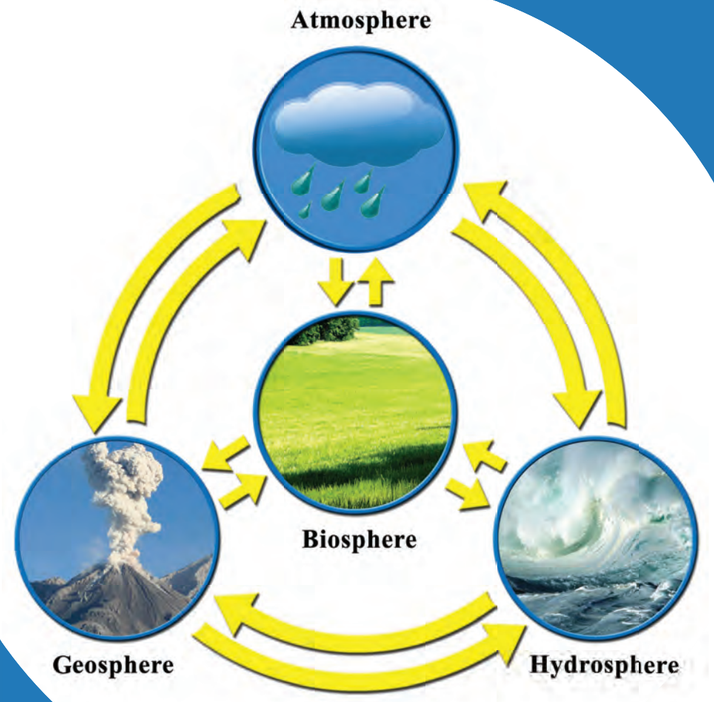
Setting up of Geodetic GNSS Receiver on Vestre Broggerbreen Glacier, Svalbard, Arctic, during August-September 2013

Colorful display of Aurora observed at Indian Antarctic station, Bharati, Larseman hills

Annual Report 2013-2014



Indian Institute of Geomagnetism

INDIAN INSTITUTE OF GEOMAGNETISM

CONTENTS

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From the Director's Desk.....

The Indian Institute of Geomagnetism (IIG) with its vast network of geomagnetic observatories at crucial locations across India is uniquely and critically poised to address the challenges emanating from both quiet and disturbed ionosphere and lithosphere conditions. Equipped with the most modern observational facilities and scientists of high-calibre, the apparent boundaries between the lithosphere-atmosphere and ionosphere become obscure at IIG. These distinctions are seamless and the focus of our current research is towards unravelling the coupled nature of these systems. Identification of the drivers of the observed processes, due to possible forcing from both "above" and "below", is a priority area of research at IIG. Understanding solar physics and space plasmas through observations and simulation are indeed our thrust areas. Introduction of novel approaches based on entropy metrics and time series modelling at the institute during the current year lent a new dimension to several research components, specifically in identification of the drivers of diverse space processes and their concomitant manifestations in geomagnetic, atmospheric and ionospheric observations besides understanding their nature. It is my firm belief that this would usher in a paradigm shift in the way these processes can be perceived henceforth.

It is heartening to report that IIG achieved an important milestone this year in understanding electrodynamics of the middle atmosphere at low latitudes through the success of the Balloon-borne Experiment on the Electrodynamics of near Space (BEENS). The instrument package on this balloon platform comprised double probe electric field instrument, fluxgate magnetometer and a search coil magnetometer measuring in all 3-axes. A float duration of about 4 hours at a ceiling altitude of 35 km was achieved during this flight. With BEENS, detection of the elusive middle atmospheric electric fields becomes a distinct possibility.

Significant new knowledge is added to our understanding of the Earth's magnetosphere from the research work done at IIG this year. It is well known that the Electromagnetic ion cyclotron (EMIC) waves play an important role in the energization and loss of magnetospheric particles. Thus, deciphering their nature is crucial to understand the inner magnetospheric dynamics. A theoretical model to study the EMIC waves in multi-component plasma is developed, and for the first time, the kappa-Maxwellian anisotropic particle distribution function

is considered for the hot protons to study these waves observed in the Earth's ring current region. Growth of the Electromagnetic ion cyclotron waves is suggested as a possible mechanism to explain the ring current decay. In another important study related to the magnetosphere, researchers at the IIG discovered that electron temperature anisotropy stimulates the dominance of mirror waves in the magnetosheath.

In studies related to the near Earth environment, seeding of scintillations, their growth and propagation continue to remain the focus of research at IIG and elsewhere, especially, in the context of space weather forecast. To the growing body of possible scintillation seeding mechanisms, scientists at IIG have recognised that Large Scale Wave Structures (LSWS) in the atmosphere may indeed trigger scintillations. Therefore, sustained monitoring of these LSWS could impart a precursory status to such structures in the occurrence of scintillations.

During the current year, the solid earth researchers at the institute were mostly content with execution of their field programs collecting high quality data through innovative field experimental design. The precise and high signal-to-noise data collected during their earlier field campaigns resulted in several very interesting findings. Important among them are - a) the Lithosphere-Asthenosphere boundary (LAB) beneath the Cambay rift shallows to 165 km from a depth of 210 km on either side, b) possible extended duration of Deccan volcanic eruption (~70 Ma – 64 Ma) is indicated from reverse polarity studies of dykes from Mumbai coast region, and c) Satellite gravity data reveals continental nature of the northern Laccadive ridge. The problem of saline sea water intrusion vis-à-vis availability of potable water resources in the SW region of Maharashtra was addressed by the scientists of IIG. Several locations of potential high quality aquifers are delineated in SW Maharashtra and the saline water interface intrusion maps for the region are also prepared for future use.

A number of new initiatives, both scientific and administrative, touching the lives of all stakeholders of IIG were witnessed during the current year. Two new interdisciplinary research programmes, one on Space weather studies and the other to capture manifestations of Earth’s deformation in the ionosphere are launched. A 256-core High Performance Computing system is being installed at IIG empowering the scientists to simulate the processes of Sun-Earth interactions. The Nanabhoy Moos Fellowship, a new Post Doc program to retain bright doctorates in India, and a special program with the acronym IMPRESS to attract young postgraduates towards research in Earth & Space sciences were introduced this year at the IIG. Further, collaborations with many universities and international institutions are now extended to enable and encourage participation by them in activities of IIG through MoUs. The institute has signed a healthy 44 MoUs till date in this regard.

The Geomagnetic observatories, the pride of IIG, continue to rank among the best in the world. In addition to the Alibag observatory, this year, the Jaipur observatory has been accredited to the prestigious International Real-time Magnetic Observatory Network (INTERMAGNET). In recognition of excellence in data quality & observatory practices, the ICSU –WDS (World Data System) has accorded full membership status to IIG. A state-of-art most modern multi-parametric Geomagnetic Observatory at Port Blair, Andamans is awaiting formal commissioning and addition to the network of IIG observatories.

The vibrant student community at the IIG made significant contributions to the well-being of this institute. Five students received their doctorate degrees this year, while three have submitted their Ph.D. theses. Several students brought home numerous awards instituted by prestigious scientific bodies & associations such as the IGU, URSI (RCRS), ISRO (NSSS), and PSSI (PLASMA) etc. Presence of distinguished academicians such as the President, AGU and Chair, CAWSES at IIG added to its aura.

Last but not the least, the administrative & supporting staff of IIG, and technical personnel at its far-flung observatories besides those at the headquarters together with colleagues from the academic stream have all contributed to the success of this institute and deserve full praise for the achievements listed in this foreword.

Before I sign-off, wishing every one the very best in the future.

D. S. Ramesh

GEOMAGNETIC DATA BASED RESEARCH

QUIET TIME VARIATIONS

Secular trend of geomagnetic elements in the Indian region

In the present study, secular trends and jerks in geomagnetic elements D, H and Z are investigated at the six Indian magnetic observatories using annual and monthly mean values for all days, quiet days and night base (night time mean). The residuals of all-day annual and monthly means are computed by removing a polynomial fit from their best fitting curves. The residuals of D, H and Z curves do not show any parallelism with the 11-year sunspot cycle. At Alibag, the D residual shows a periodicity of 2 solar cycles, whereas the H and Z residuals indicate a quasi-periodicity of 3 solar cycles for the period 1921-2009. At the Indian stations, an in-phase solar cycle component is observed for 2 of the solar cycles in the D and Z residuals, while the H residual shows out of phase variations with the sunspot cycle for the period 1958 – 2009. Two geomagnetic jerks, 1970 and 1991, are well reflected in monthly and annual mean values in Indian region, as observed globally *(**S. K. Bhardwaj**, **P. B. V. Subba Rao**)*.

EFFECT OF GEOMAGNETIC DISTURBANCES

An extreme coronal mass ejection and consequences for the magnetosphere and Earth

A "perfect" interplanetary coronal mass ejection could create a magnetic storm with intensity up to the saturation limit (*Dst* ~ −2500 nT), a value greater than the Carrington storm. Many of the other space weather effects will not be limited by saturation effects, however. The interplanetary shock would arrive at Earth within ~12 h with a magnetosonic Mach number ~45. The shock impingement onto the magnetosphere will create a sudden impulse of ~234 nT, the magnetic pulse duration in the magnetosphere will be ~22 s with a dB/dt of ~30 nT s^{-1}, and the magnetospheric electric field associated with the dB/dt ~1.9 V m^{-1}, creating a new relativistic electron radiation belt. The magnetopause location of 4 R_E from the Earth's surface will allow expose of orbiting satellites to extreme levels of flare and ICME shock-accelerated particle radiation. The results of present calculations are compared with current observational records. Comments are made concerning further data analysis and numerical modeling needed for the field of space weather *(B.T. Tsurutani (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA);**G. S. Lakhina**)*.

Characteristics of penetration electric fields to the equatorial ionosphere during southward and northward IMF turnings

The signatures of abrupt turnings of the vertical component of the interplanetary magnetic field (IMF), Bz, can be seen at equatorial latitudes through the prompt transmission of high-latitude electric fields to the lower latitudes, called as prompt penetration electric field (PPE). The signatures of PPE in daytime equatorial electrojet (EEJ) index derived in the Indian sector during 2001–2005 have been studied. The signatures are observed in polar (PCN index) and equatorial (EEJ index) ionosphere almost instantaneously (< 1min). The communication time of 12 min is observed between bow shock nose and the equatorial ionosphere, and it is found to have inverse relationship with radial component of solar wind velocity during southward and northward Bz turnings which might indicate magnetosphere crossing time scale by solar wind. Ionospheric reconfiguration time during southward turnings shows inverse relationship with solar wind flow in contrast to northward turnings with "no relationship", indicating differences in underlying physical mechanisms during both turnings. It is observed that no local time dependence (within 06–18h) in conductivity-corrected EEJ signatures associated with Bz turnings. Regression analysis between conductivity-corrected EEJ and interplanetary electric field shows higher efficiency during northward turnings. However, further analysis investigating the effect of actual orientation of Bz indicates that the magnitude of northward Bz does not have influence on the ionospheric signatures. It is noticed that the response signatures are mainly controlled by the magnitudes of southward Bz. Thus, the present study signifies the role of inner magnetospheric shielding electric field in addition to ceasing of convection during northward turnings*(**Bhaskar Ankush, Geeta Vichare**)*.

Signatures of moderate (M-class) and low (C, B class) intensity solar flares on the equatorial electrojet current: case studies

The present investigation brings out, in contrast to the earlier works, the changes in the equatorial electrojet (EEJ) current in response to a few moderate (M-class) and low(C and B class) intensity solar flares during 2005–2010.Special care is taken to pick these flare events in the absence of prompt electric field perturbations associated with geomagnetic storms and substorms that also affect the electrojet current.

Interestingly, only the normalized (with respect to the pre-flare level) deviations of daytime EEJ (and not the deviations alone) change linearly with the increase in the EUV and X-ray fluxes. These linear relationships breakdown during local morning hours when the E-region electric field approaches zero before reversal of polarity. This elicits that the response of EEJ strength corresponding to less-intense flares can be appropriately gauged only when the local time variation of the quiet time E-region zonal electric field is taken into account. The flare events enhanced the EEJ strength irrespective of normal or counter electrojet (CEJ) conditions that shows that solar flares change the E-region ionization density and not the electric field. In addition, the enhancements in the X-ray and EUV fluxes, for these flares occurring during this solar minimum period, are found to be significantly correlated as opposed to the solar maximum period, indicating the differences in the solar processes in different solar epochs*(D. Chakrabarty (Physical Research Laboratory, Ahmedabad);* ***Mala. S. Bagiya****; S. V. Thampi (Physical Research Laboratory, Ahmedabad);****B. M. Pathan****; R. Sekar (Physical Research Laboratory, Ahmedabad)).*

Study of simultaneous presence of DD and PP electric fields during the geomagnetic storm of November 7–8, 2004 and resultant TEC variation over the Indian Region

During very intense geomagnetic storm of 7-8 November 2004 simultaneous presence of storm time disturbance dynamo and eastward and westward directed prompt penetration electric fields inferred from the ground based magnetometer data in the 75° E sector is presented. Magnetometer observations show that, on the whole, average ΔH variation on 8 November remains below the night time level compared to its quiet day variation. A number of upward and downward excursions have been observed between 0130 UT and 0800 UT in the ΔH variation on 8 November. These excursions in ΔH have been attributed to the episodes of eastward and westward prompt penetrating electric fields. Ionospheric response in the equatorial ionization anomaly region along 75° E has also been studied using the total electron content data recorded at five GPS stations, namely Udaipur, Bengaluru (IISC), Hyderabad (HYDE), Maldives (MALD) and Diego Garcia (DGAR). Observation of markedly suppressed EIA, in conjunction with ΔH variation which was mostly negative during the daytime on 8 November, indicates the presence of an external field of opposite polarity (the disturbance dynamo electric field) that either undermined, or overshadowed the daytime ambient (eastward) electric field to the extent that the equatorial plasma fountain could not become effective **(Figure 1)** *(P. Galav (Department of Physics, M.L.S. University, Udaipur); S. Sharma(GB Pant Hospital, New Delhi); S.S. Rao ·(Department of Physics, M.L.S. University, Udaipur);****B. Veenadhari****; T. Nagatsuma (National Institute of Information and Communications Technology, Japan); R. Pandey (Department of Physics, M.L.S. University, Udaipur)).*

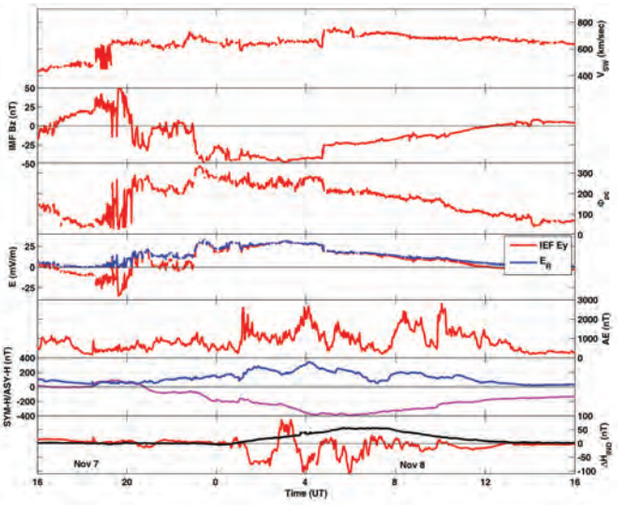


Figure 1

Variation of the solar wind speed, IMF B_z (shifted appropriately by the time of arrival to the magnetopause), cross polar potential drop, zonal interplanetary electric field (IEF E_y), reconnection electric field E_R, AE index, SYM-H and ASY-H indices, and Δ H_{IND} variations on November 7–8, 2004

Response of the equatorial and low-latitude ionosphere to an intense X-class solar flare (X7/2B) as observed on 09 August 2011

Response of equatorial and low-latitude ionosphere to an intense solar flare of class X7/2B that peaked at 08:05 UT on 09 August 2011 in the solar cycle 24 is studied. Global positioning system total electron content (TEC) observations in the sunlit hemisphere show enhancement of ~3 TEC units, while geomagnetic H component observations indicate sudden decrease and increase in their strength at equatorial and low-latitude stations, respectively, at several stations in the sunlit hemisphere. In addition, equatorial electrojet strength over Indian region reveals commencement of counter electrojet. Simultaneous Canadian Advanced Digital Ionosonde observations at Tirunelveli, an equatorial station in India, show the disappearance of ionogram echoes during the flare event indicating absorption of radio signals in the *D* region. Strong equatorial blanketing type E_s layer was observed in the ionogram records at Tirunelveli prior to the occurrence of the solar flare that continued for several hours

though it became weak/absent during the flare event. Ionogram records on the control day show regular *F* layer movement without any blanketing type E_s layer. Very low frequency (VLF) observations at Allahabad, an Indian low-latitude station, show enhanced VLF amplitude signal during the same time revealing the sudden enhancement of *D* region ionization. Using the observations presented here, an attempt has been made to study the impact of the solar flares on the electrodynamics of the equatorial and low-latitude ionosphere*(**S. Sripathi**; N. Balachandran (Mahatma Gandhi University, Kottayam);**B. Veenadhari,R. Singh, K. Emperumal**).*

UPPER ATMOSPHERIC RESEARCH

MESOSPHERE-LOWER THERMOSPHERE STUDIES

Planetary-scale wave structures of Earth's Atmosphere using COSMIC observations

GPS radio occultation (GPS RO) method, an active satellite-to-satellite remote sensing technique, is capable of producing accurate, all-weather, round-the clock, global refractive index, density, pressure, and temperature profiles of the troposphere and stratosphere. This study presents planetary-scale equatorially trapped Kelvin waves in temperature profiles retrieved using COSMIC satellites during 2006- 2009 and their interactions with background atmospheric conditions. It is not only found that the Kelvin waves are associated with wave periods of higher than 10 days (slow Kelvin waves) with higher zonal wave numbers (either 1 or 2), but also found that these waves are possessing downward phase progression giving evidences that the source region of them are located at lower altitudes. A thorough verification of outgoing long-wave radiation (OLR) reveals the deep convection activity has been developed regularly over the Indonesian region, indicating that the Kelvin waves are driven by convective activity. The derived Kelvin waves showing enhanced (diminished) tendencies during westward (eastward) phase of quasi-biennial oscillation (QBO) in zonal winds, which implying the mutual relation between both of them. The El-Nino and southern oscillation (ENSO) below 18 km and QBO features between 18 and 27 km in temperature profiles are observed during May 2006-May 2010 with the help of an adaptive data analysis technique known as Hilbert Huang Transform (HHT). Further, temperature anomalies computed using COSMIC retrieved temperatures are critically evaluated during different phases of ENSO, which revealed few interesting results and are discussed in light of available literature*(A.S.K.A.V. Prasad Rao, P. S. Brahmanandam (National Central University, Taiwan); G. Uma (K. L. University, Vaddeswaram); A. Narendra Babu (LBR Engg College, Mylavaram); C. Y. Huang (National Central University, Taiwan); G. Anil Kumar (K. L. University, Vaddeswaram);**S. Tulasi Ram**;H. L. Wang, Y. H. Chu(National Central University, Taiwan)).*

STUDY OF GLOBAL ELECTRIC CIRCUIT

Atmospheric electric parameters and micrometeorological processes during the solar eclipse on 15 January 2010

Indian scientists got the unique opportunity to study the near-Earth environment during a long annular solar eclipse at the end of the last long deep solar minimum, on 15 January 2010. Continuous high time resolution records of the atmospheric electric parameters and meteorological parameters were made at Tirunelveli (8.07°N, 77.08°E, 35 m Above Mean Sea Level (AMSL) and Braemore Hill (8.41°N, 76.59°E, 460 m AMSL) stations where the eclipse was during 11:07:57–15:06:52 IST with maximum obscuration (~90%) at 13:17:09 Indian Standard Time (IST). The recorded values of the parameters show marked deviations from those normally observed on control fair-weather days. The ambient electric field underwent a large drop by up to 65% during the eclipse, and potential gradient showed epochs of enhancements during and after the eclipse until postsunset. The data also seem to reveal the long lasting paradox of conductivity enhancement during eclipse, which may be due to the eclipse induced upsurge of low winds or waves that brings high density of free space charges embedded in air parcels *(**C. P. Anil Kumar, R. Gopalsingh, C. Selvaraj, K. U. Nair, H. Johnson Jeyakumar**; R. Vishnu, S. Muralidas (Centre for Earth Science Studies, Thiruvananthapuram); N. Balan (Institute of Space Sciences, National Central University, Chung_Li, Taiwan)).*

IONOSPHERIC IRREGULARITIES: SCINTILLATION STUDIES

Development of intermediate scale structure near the peak of the F region within an equatorial plasma bubble

Scintillation observations are used to study the evolution of intermediate scale (~100 m–few kilometers) irregularities through growth of the Rayleigh Taylor (R-T) instability on the bottom side of the post-sunset equatorial **F** region during magnetically quiet periods. Amplitude scintillations on a VHF signal from a geostationary satellite, recorded by spaced receivers at an equatorial station, are used to compute as a function of local time: (1) the coherence scale length for spatial variations of intensity in the ground scintillation pattern, which is linked with the spectrum of the intermediate scale irregularities near the peak of the equatorial **F** region that contribute the most to the observed scintillations; and (2) the "random velocity", which accounts for the de-correlation of the spaced receiver signals. The relationship between the coherence scale length and the random velocity for saturated scintillations at different local times suggests that (1) the random velocity is linked with fluctuations in the drift velocity of the irregularities caused by the perturbation electric fields associated with the R-T instability rather than structural changes in the intermediate scale irregularities, (2) the spectrum of intermediate scale irregularities in the equatorial **F** peak region tends to be shallowest after the decay of the perturbation electric fields associated with the R-T instability, and (3) evolution of intermediate-scale irregularity spectrum in the equatorial plasma bubble near the equatorial **F** region peak depends on season and solar flux. These have implications for observation of low-latitude L-band scintillations *(**A. Bhattacharyya**, **B. Kakad**, **K.U. Nair, K. Jeeva**).*

A study on ionospheric scintillation near the EIA crest in relation to equatorial electrodynamics

Equatorial electrojet (EEJ) data, which are considered as a proxy index of equatorial electric field,are analyzed in conjunction with equatorial ionosonde, total electron content (TEC) and scintillation data near the equatorial ionization anomaly (EIA) crest for the equinoctial months of high solar activity years (2011–2012) to identify any precursor index of postsunset evolution of equatorial electron density irregularities and subsequent occurrence of scintillation near the northern EIA crest. Only geomagnetically quiet and normal electrojet days are considered. The diurnal profiles of EEJ on the scintillation days exhibit a secondary enhancement in the afternoon to presunset hours following diurnal peaks. A series of electrodynamical processes conducive for generation of irregularities emerge following secondary enhancement of EEJ. Latitudinal profile of TEC exhibits resurgence in EIA structure around the postsunset period. Diurnal TEC profile near the EIA crest resembles postsunset secondary enhancement on the days with afternoon enhancement in EEJ. Occurrence of equatorial spread F and postsunset scintillation near the EIA crest seems to follow the secondary enhancement events in EEJ. Both the magnitude and duration of enhanced EEJ are found to be important for postsunset intensification of EIA structure and subsequent occurrence of equatorial irregularities. A critical value combining the two may be considered an important precursor for postsunset occurrence of scintillation near the EIA crest. The results are validated using archived data for the years 1989–1990 and explained in terms of modulation effects of enhanced equatorial fountain *(S.Chatterjee, S.K.Chakraborty (Dept of Physics, Raja Peary Mohan College, Uttarpara,India); **B.Veenadhari, S.Banola**).*

Characteristics of Large Scale Wave Structure (LSWS) observed from African and southeast Asian longitudinal sectors

The spatial large-scale wave structure (LSWS) at the base of F layer is the earliest manifestation of seed perturbation for Rayleigh-Taylor instability, hence, found to play a deterministic role in the development of Equatorial Plasma Bubbles (EPBs). Except for a few case studies, a comprehensive investigation has not been conducted on the characteristics of LSWS because of the complexity involved in detecting the LSWS, particularly, in spatial domain. In this scenario, a comprehensive study is carried out, for the first time, on the spatial and temporal characteristics of LSWS observed in spatial domain over African and Southeast Asian longitudinal sectors during the year 2011. The observations indicate that these wave structures can be detected a few degrees west of E region sunset terminator and found to grow significantly at longitudes past the sunset terminator. The phase fronts of these spatial structures are found to align with the geomagnetic field lines over a latitudinal belt for at least 5 - 6° (~500–600 km) cantered on dip equator. The zonal wavelengths of these structures are found to vary from 100 to 700 km, which is consistent with the earlier reports, and the EPBs were consistently observed when the amplitudes of LSWS were grown to sufficient strengths. These results would provide better insights on the underlying physical processes involved in excitation of LSWS in terms of important roles being played by E region electrical loading and polarization electric fields induced via spatially varying

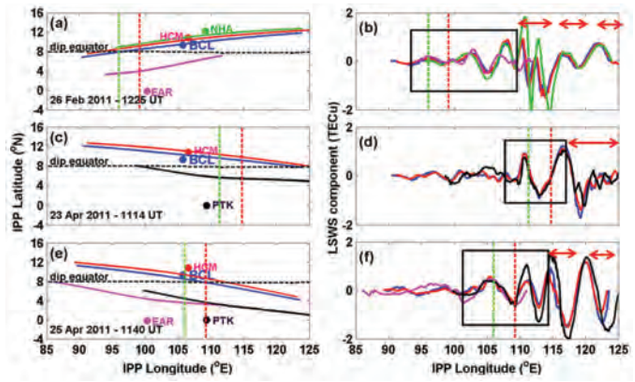


Figure 2

Simultaneous observations of LSWS from five low-latitude stations that are spatially distributed over Southeast Asian region. The phase fronts of spatial large scale wave structure (LSWS) are found to align with the geomagnetic field ($\vec{B}$) lines around dusk hours over a wide latitudinal belt for at least 5 - 6° (~500–600 km) cantered on dip equator. Further, the EPBs and scintillation were consistently observed when the amplitudes of LSWS were grown to sufficient strengths (indicated by horizontal arrows)

dynamo current due to neutral wind perturbations associated with atmospheric gravity waves **(Figure 2)** (***S. Tulasi Ram**;M. Yamamoto (RISH, Kyoto Univeristy, Japan); R. T. Tsunoda (SRI International, USA); H. D. Chau, T. L. Hoang (Hanoi Institute of Geophysics, Vietnam); B. Damtie, M. Wassaie (Bahirdar University, Ethopia); C. Y. Yatini, T. Manik (LAPAN, Indonesia); T. Tsugawa (NICT, Japan))*.

Critical assessment of the forecasting capability of L-band scintillations over the magnetic equatorial region – Campaign results

A critical evaluation to forecast L-band scintillation is made using the results from a special campaign conducted from Trivandrum (8.5°N, 76.91°E, dip latitude 0.5°N),India, during April 2012. The significance of the campaign lies in the fact that, 1) efforts are made to minimize the uncertainties due to the movement of the satellite platform (TEC and S4 observations from GNSS satellites) by choosing a recently launched GSAT-8 geostationary satellite for ionospheric scintillation in L1 band, 2) unlike the previous study wherein the GPS derived TEC fluctuations were treated as representative of ionospheric perturbations, in the present exercise, the fluctuating component of the foF2 data from the ground based digital Ionosonde have been taken as a measure of the perturbations and 3) though both the GSAT and Ionosonde are stationary, still the ionospheric regions they represent are physically separated and in order to correlate the scintillation over the GSAT location to the forecast perturbations over the ionosonde location, the required zonal velocity of the perturbations/irregularities is estimated using GSAT and GPS scintillation data during one of the close-by GPS passes and this is taken to represent the particular solar epoch and season. The relative amplitudes and phase integrity of the perturbations have been maintained and extended throughout night. By adopting the above changes, it has been noted that the forecasting capability of L band scintillation has remarkably improved vindicating the role of perturbations in the evolution of the scintillation, thus making it more useful for practical applications. The non occurrence of scintillation on occasions in the prescribed time windows has also been understood based on the changes in the background conditions. A threshold upward velocity for the evening F-region as early as 1730-1830 LT, has been worked out to be 5 ms^{-1} for the ESF to get triggered and for its sustenance, a plasma scale length of < 20 km along with a critical base height (h'F) of 225 km have been evaluated as necessary background conditions **(Fig.3 a,b,c)** (***Mala. S. Bagiya**; R. Sridharan (Physical Research*

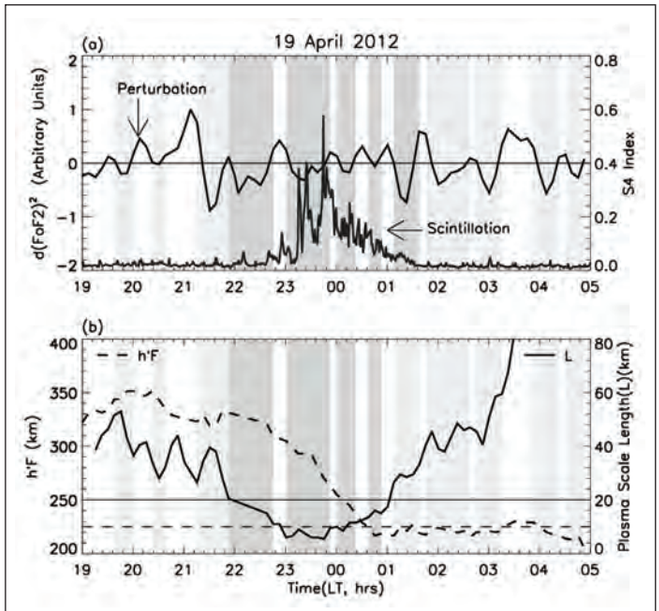


Figure 3a

Forecast density perturbations [d(foF2)^2] along with the actual S_4 index from GSAT observations, (b) h'F (base height) of F-region and plasma scale length L variations during 1900 to 0500 LT on 19th April 2012. The dark shaded regions show the time windows where scintillation forecast has been successful. The light shaded regions show the windows where scintillation was forecast but did not occur.

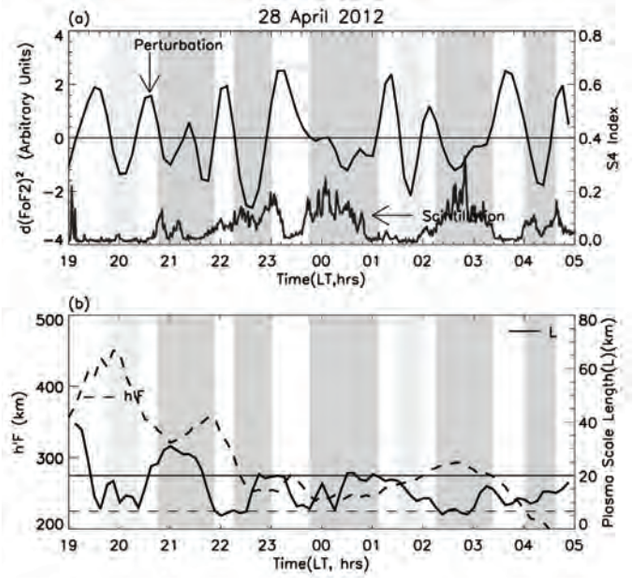


Figure 3b

Same as for figure 3a but for 28th April 2012. The conspicuous absence of scintillations during 1930-2030 LT when both the background conditions and the phase of the perturbation favour the generation of irregularities and its presence during 2030- 2130 LT when not favoured by L and during 0400-0500 LT when not supported by h'F, are to be noted.

Laboratory, Ahmedabad); S. Sunda (Space Application Centre, Ahmedabad); L. Jose, T. K. Pant, R. Chaudhary (Space Physics Laboratory, VSSC, Trivandrum)).

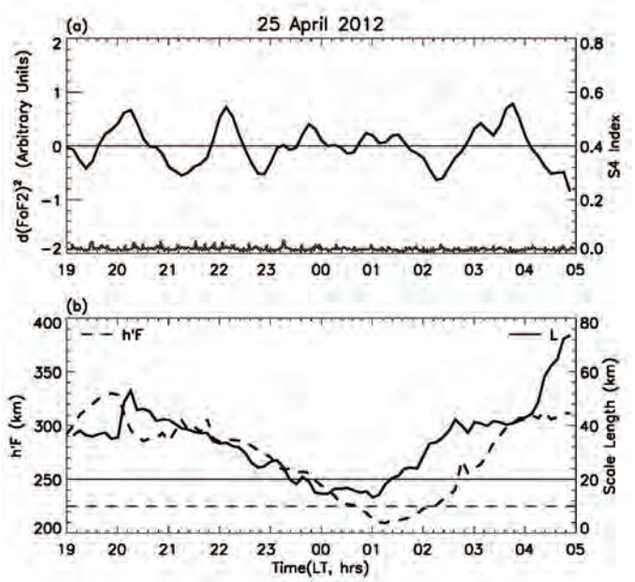


Figure 3c

Depicts the situation on one of the non ESF days, 25th April 2012. (a) and (b) are as in Figure 3a.

IONOSPHERIC IRREGULARITIES: RADAR STUDIES

On the pre-midnight ascent of F-layer in the June solstice during the deep solar minimum in 2008 over the Indian sector

Investigations on the variations of the virtual height (h'F) of the base of the F-layer over Thumba (8.5°N, 77°E, dip lat 0.5°N) in 2002 (high solar activity) and 2008 (very low solar activity) under quiet geomagnetic conditions show characteristic pre-midnight rise of h'F in the June solstice of 2008. Comparison of the h'F variations in 2008 over Thumba and Fortaleza (3.9°S, 38.4°W, dip lat 1.8°S), Brazil, reveals that the pre-midnight rise of h'F is significantly more over Thumba during the June solstice. Drift measurements on-board the Communication/Navigation Outage Forecasting System (C/NOFS) satellite elicit that the midnight upward drift over the Indian sector during the northern summer months of 2009 is the largest, a feature that significantly weakens in 2010. C/NOFS measurements also confirm the electro-dynamical nature of the pre-midnight h'F rise over the Indian sector in the June solstice during the low solar activity. As the equatorial F-region vertical drifts during nighttime are controlled by E-region dynamo driven by tidal wind system, systematic wind measurements at upper mesospheric heights by an MF radar (1.98 MHz) from Tirunelveli (8.7°N, 77.8°E, dip lat 0.5°S), India, during 2000–2011 are used to derive the tidal components. This reveals that the phases of both the meridional and zonal components of the diurnal tide regress while the phase of the meridional component of the semidiurnal tide significantly advances with decreasing solar activity with concomitant increases in amplitudes during the summer months. These observations suggest the possible semidiurnal tidal influence on the pre-midnight h'F rise over the Indian sector in the June solstice during low solar activity *(D. Chakrabarti, R. Sekar (Physical Research Laboratory, Ahmedabad); B. G. Fejer (Center for Atmospheric and Space Sciences, Utah State University, Logan, USA); **S. Gurubaran**; Tarun K. Pant (Space Physics Laboratory, Vikram Sarabhai Space Centre, Trivandrum); M. A. Abdu (Instituto Nacional de Pesquisas Espaciais-INPE, Sao Jose dos Campos, Brazil)).*

Ionospheric variability over Indian low latitude linked with the 2009 sudden stratospheric warming

Radar observations of **E**x**B** drift and plasma irregularities, ionosonde observations of E- and F-layer parameters including spread F, and magnetic field observations made from Indian low latitudes linked with the 2009 sudden stratospheric warming (SSW) event have been analysed.

Ex**B** drift variations presented here are the first of their kind from the Indian sector as far as the effect of SSW is concerned. Difference of magnetic fields observed from the equator and low latitude (**Δ**H) and **E**x**B** drift show linear relation and both show remarkably large positive values in the morning and negative values in the afternoon exhibiting semidiurnal behavior. Remarkable changing patterns in the critical frequency of F_2 layer (f_oF_2) and F_3 layer (f_oF_3) were observed after the occurrence of SSW. Large variations with quasi-16-day periodicity were observed in **Δ**H, f_oF_2 and f_oF_3. Both semidiurnal and quasi-16-day wave modulation observed after the 2009 SSW event are consistent with those reported earlier. A quasi-6 day variations in **Δ**H and f_oF_2 were noted soon after the SSW commencement, not much reported before. During the counter-electrojet events linked with the SSW event, while equatorial E_s (E_{sq}) disappeared as expected, there were no blanketing E_s (E_{sb}), a finding not reported and discussed earlier. E_{sb} was also not formed at the off-equatorial location, indicating the absence of required vertical wind shear, but E region plasma irregularities were observed by the ionosonde and radar with a close relationship between the two. Weak F region irregularities were observed

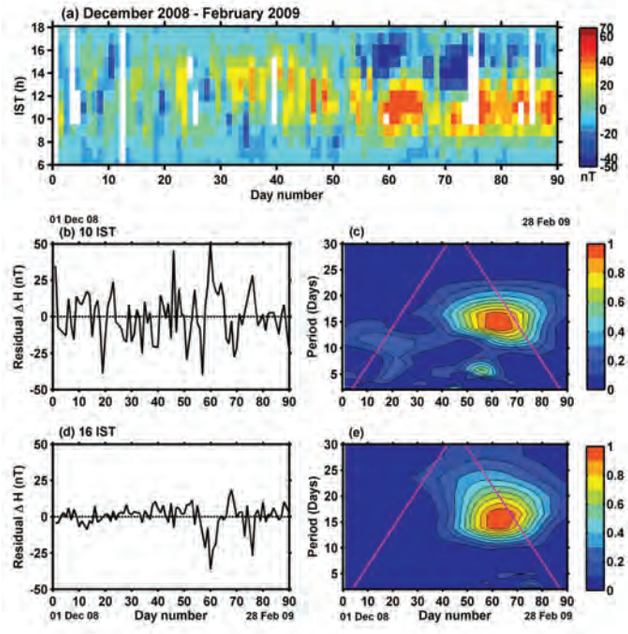


Figure 4

(a) Daytime variation of ΔH during December 2008-February 2009, (b) variation of ΔH as a function of day number observed at 10 IST, (c) wavelet spectrum displaying the dominant periods in ΔH observed at 10 IST as a function of day number, (d) variation of ΔH as a function of day number observed at 16 IST, and (e) wavelet spectrum displaying the dominant periods in ΔH observed at 16 IST as a function of day number.

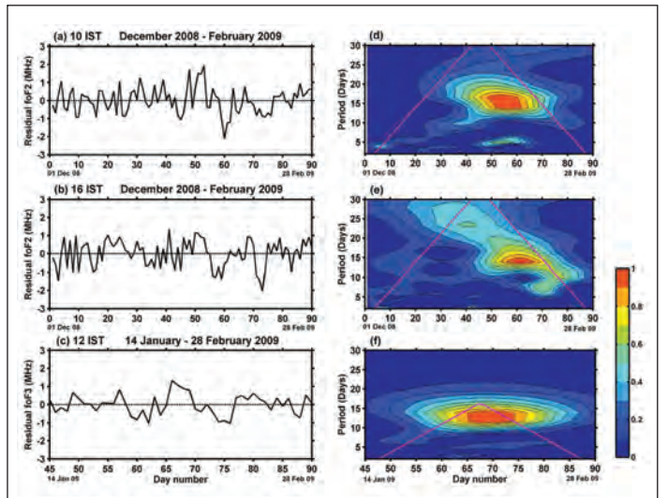


Figure 5

Variation of foF2 observed at (a) 10 IST and (b) 16 IST and (c) foF3 observed at 12 IST as a function of day number. Wavelet spectrum of foF2 corresponding to the observations at (d) 10 IST and (e) 16 IST and foF3 (f) corresponding to the observations at 12 IST as a function of day number. In case of foF3, observations made since 14 January (day number 45) have been used since F3 layer was observed regularly only after 14 January.

in the post-midnight hours and case studies suggest the possible role of SSW related background electric field in the manifestation of post-midnight F region irregularities **(Fig.4,5)** *(Patra, A.K., P.P. Chaitanya (NARL, Gadanki);* ***S. Sripathi, S. Alex****)*.

IONOSPHERIC IRREGULARITIES: AIRGLOW STUDIES

Zonal velocity of the equatorial plasma bubbles over Kolhapur, India

This paper presents the observations of zonal drift velocities of equatorial ionospheric plasma bubbles and their comparison with model values. These velocities are determined by nightglow OI 630.0 nm images. The nightglow observations have been carried out from the low latitude station Kolhapur (16.8° N, 74.2° E; 10.6° N dip lat.) during clear moonless nights. Herein the drift velocities of equatorial plasma bubbles for the period of February–April 2011 have been presented. Out of 80 nights, 39 showed the occurrence of equatorial plasma bubbles (49%). These 39 nights correspond to magnetically quiet days (ΣKp < 26). The average eastward zonal velocities (112 ± 10 m s^{-1}) of equatorial plasma bubbles increased from evening sector to 21:00 IST (Indian Standard Time = Universal Time + 05:30:00 h), reach maximum about 165 ± 30 m s^{-1} and then decreases

with time. The calculated velocities are in good agreement with that of recently reported values obtained with models with occasional differences; possible mechanisms of which are discussed*(D. P. Nade, A. K. Sharma, S. S. Nikte (Department of Physics, Shivaji University, Kolhapur);* ***P. T. Patil, R. N. Ghodpage****;M. V. Rokade (Centre for Materials for Electronics Technology, Hyderabad);****S. Gurubaran****;A. Taori (National Atmospheric Research Laboratory, Gadanki, India);Y. Sahai (Universidade do Vale do Paraiba (UNIVAP), Sao Jose dos Campos, Brazil)).*

A study on the night time equatorward movement of ionization anomaly using thermospheric airglow imaging technique

In the night time low latitude ionosphere, the equatorial ionization anomaly (EIA) crest move towards the equator as a result of change in the direction of the zonal electric field from eastward to westward. This is referred to as reverse plasma fountain. On some nights, imaging observations of OI 630.0 nm thermospheric nightglow taken from low latitude Indian station Panhala (16.8°N, 74.1°E; 11.1°N dip latitude) during deep solar minimum period revealed southward movement of a broad enhanced airglow intensity region that is aligned along east–west direction. This could be seen in the meridional keograms **(Fig.6)** and is interpreted as the equatorward passage of the EIA crest. The studies that concentrate on the night time evolution of EIA with the help of airglow observations are sparse. In addition to the equatorward motion, the thickness of the crest region decreased as a result of recombination. This reduction in thickness is pronounced in the earlier part of the night and brings about an apparent drift that is added to the true equatorward drift of the EIA crest. In this work, a method to measure the equatorward drift speed of the EIA crest from airglow imaging observations has been described. The method includes the estimation and correction for the apparent drift caused by recombination. The results show that drift speed varies widely between 28 m/s and 89 m/s (~100 km/h to ~315 km/h) with an average speed of 52 m/s (188 km/h). A part of the variability might be due to variations in thermospheric meridional wind. The drifts observed during magnetically disturbed days were found to be relatively smaller than that on quiet days *(**V. Lakshmi Narayanan, S. Gurubaran, K. Emperumal, P. T. Patil**).*

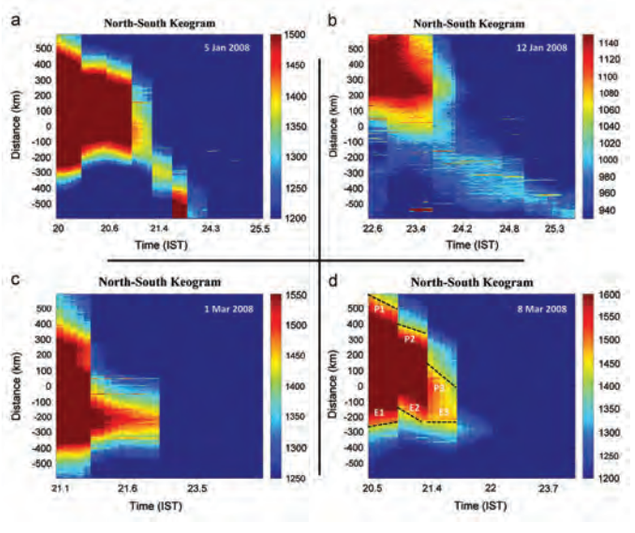


Figure 6

The North-South keograms obtained from the all-sky images of 630.0 nm nightglow emission on four nights during January-March 2008 from Panhala.

Occurrence of equatorial plasma bubbles over Kolhapur

This paper reports the nightglow observations of OI 630.0 nm emissions, made by using all sky imager operating at low latitude station Kolhapur (16.8°N, 74.2°E and dip lat. 10.6°N) during high sunspot number years of 24th solar cycle. The images are analyzed to study the nocturnal, seasonal and solar activity dependence occurrence of plasma bubbles. EPBs in images were observed regularly during a limited period 19:30 to 02:30 LT and reach maximum probability of occurrence at 22:30 LT. The observation pattern of EPBs shows nearly no occurrence during the month of May and it maximizes during the period October–April. The equinox and solstice seasonal variations in the occurrence of plasma bubbles show nearly equal and large differences, respectively, between years of 2010–11 and 2011–12*(A. K. Sharma, D. P. Nade, S. S. Nikte (Department of Physics, Shivaji University, Kolhapur);****P. T. Patil, R. N. Ghodpage****; R. S. Vhatkar, M. V. Rokade (Department of Physics, Shivaji University, Kolhapur);****S. Gurubaran****).*

A case study of gravity waves observed in OH rotational temperatures at Kolhapur (16.8º N, 74.1º E), India

Ground-based measurements of OH (8, 3) Meinel band emissions were carried out at Kolhapur (16.8º N, 74.1º E), India during the period November 2002 – May 2003 using two tilting filter photometers. OH rotational temperature ~ a proxy of atmospheric temperature around 87 km, were derived from the intensity information of $P_1(2)$ and $P_1(4)$ lines of OH (8, 3) band. On most nights, strong well-defined oscillations having periodicities in the range of 1 – 3 h were observed in OH temperature series. Here, a case study of such short-period oscillations observed on few nights in the OH temperature has been presented*(**N. Parihar, G. K. Mukherjee**).*

IONOSPHERIC TEC & MODELING

Three-dimensional GPS ionospheric tomography over Japan using constrained least squares

A new three-dimensional GPS ionospheric tomography technique is developed that uses total electron content (TEC) data from the dense Global Position System (GPS) receiver network, GPS Earth Observation Network (GEONET) in Japan, and it will not require an ionospheric model as the initial guess that will bias the reconstruction of electron density. The GEONET is operated by Geospatial Information Authority of Japan and consists of more than 1200 receivers; this high density and wide coverage helps to reconstruct the electron density distribution in the ionosphere with high spatial resolution. This tomography technique uses a constrained least squares fit to reconstruct the three-dimensional electron density distributions. This method is different to most other techniques as they require a background ionospheric model as an initial guess that could bias the reconstructed electron density. It rather uses a prior condition that the electron density should not exceed a certain value that is determined by the restrain parameter, which is derived from the NeQuick model. Its independency of the initial guess from a model will make it useful even in disturbed conditions. This paper presents results that are obtained by using this new tomographic technique. The reconstruction of three-dimensional ionospheric tomograms is demonstrated using the GPS data, and the reliability and robustness are checked with simulated tomograms obtained using the synthetic GPS-TEC data produced using NeQuick model*(**G. K. Seemala**; M. Yamamoto (Research Institute for Sustainable Humanosphere, Kyoto University, Japan); A. Saito (Department of Geophysics, Kyoto University, Japan); C.H. Chen (Department of Earth Science, National Cheng Kung University, Taiwan)).*

Comparison of equatorial GPS-TEC observations over an African station and an American station during the minimum and ascending phases of solar cycle 24

GPS-TEC data were observed at the same local time at two equatorial stations on both longitudes: Lagos (6.52 N, 3.4 E, and 3.04 S magnetic latitude), Nigeria; and Pucallpa (8.38 S, 74.57 W, 4.25 N magnetic latitude), Peru during the minimum (2009, 2010) and ascending (2011) phases of solar cycle 24. These data were grouped into daily, seasonal and solar activity sets. The day-to-day variations in vertical TEC (VTEC) recorded the maximum during 14:00–16:00 LT and minimum during 04:00–06:00 LT at both longitudes. Seasonally, during solar minimum, maximum VTEC values were observed during March equinox and minimum during solstices. However, during the ascending phase of the solar activity, the maximum values were recorded during the December solstice and minimum during the June solstice. VTEC also increased with solar activity at both longitudes. On longitude by longitude comparison, the African GPS station generally recorded higher VTEC values than the American GPS station. Furthermore, harmonic analysis technique was used to extract the annual and semi-annual components of the amplitudes of the TEC series at both stations. The semi-annual variations dominated the TEC series over the African equatorial station, while the annual variations dominated those over the American equatorial station. The GPS-TEC-derived averages for non-storm days were compared with the corresponding values derived by the IRI-2007 with the NeQuick topside option. The NeQuick option of IRI-2007 showed better performance at the American sector than the African sector, but generally underestimating TEC during the early morning hours at both longitudes*(A. O. Akala (Department of Physics, University of Lagos, Akoka, Yaba, Lagos, Nigeria);**G. K. Seemala**; P. H. Doherty, C. E. Valladares, C. S. Carrano (Institute for Scientific Research, Boston College, Chestnut Hill, MA, USA); J. Espinoza (Jicamarca Radio Observatory, Lima, Peru); S. Oluyo (Department of Physical Science, Yaba College of Technology, Yaba, Lagos, Nigeria)).*

Modeling and observations of the north-south ionospheric asymmetry at low latitudes at long deep solar minimum

Using the physics based model SUPIM and FORMOSAT-3/COSMIC electron density data measured at the long deep solar minimum (2008–2010), the longitude variations of the north–south asymmetry of the ionosphere at low latitudes (±30° magnetic) are investigated. The data at around diurnal maximum (12:30–13:30 LT) for magnetically quiet (Ap ≤15) equinoctial conditions (March–April and September–October) are presented for three longitude sectors (a) 60°E–120°E, (b) 60°W–120°W and (c) 15°W–75°W. The sectors (a) and (b) have large displacements of the geomagnetic equator from geographic equator but in opposite hemispheres with small magnetic declination angles; and sector (c) has large declination angle with small displacement of the equators; vertical ExB drift velocities also have differences in the three longitude sectors. SUPIM investigates the importance of the displacement of the equators, magnetic declination angle, and ExB drift on the north–south asymmetry. The data and model qualitatively agree; and indicate that depending on longitudes both the displacement of the equators and declination angle are important in producing the north–south asymmetry though the displacement of the equators seems most effective.

This seems to be because it is the displacement of the equators more than the declination angle that produces large north–south difference in the effective magnetic meridional neutral wind velocity, which is the main cause of the ionospheric asymmetry. For the strong control of the neutral wind, east–west electric field has only a small effect on the longitude variation of the ionospheric asymmetry. Though the study is for the long deep solar minimum, the conclusions seem valid for all levels of solar activity since the displacement of the equators and declination angle are independent of solar activity *(N. Balan, P. K. Rajesh (National Central University, Taiwan);**S. Sripathi,S. Tulasi Ram**;J. Y. Liu (National Central University, Taiwan); J. Bailey (University of Sheffield, UK)).*

ULF/ELF/VLF WAVES

Energetic electron (>10keV) microburst precipitation, ~5–15 s x-ray pulsations, chorus and wave-particle interactions: a review (2013)

The fundamental features of ~0.1–0.2 s duration ~0.5 s spaced ionospheric electron precipitation "microbursts," ~5 to 15 s microburst "trains" and 5–15 s electron precipitation pulsations are reviewed in light of similar temporal structures of electromagnetic whistler mode "chorus" waves detected in the outer magnetosphere. Past observations of microbursts point to extremely rapid (ms timescale) wave-particle interactions, probably between lower band chorus subelements (durations of ~10 to 100 ms) and energetic ~10 to 100 keV electrons. A recent theory explaining such rapid interaction rates observed in microbursts is briefly reviewed. Arguments are given why ~5–15 s X-ray (and optical) pulsations are also associated with chorus scattering of energetic electrons. Comments about relativistic (E > 1 MeV) microbursts are also provided. There are, however, many other unsolved problems of outer zone energetic electron precipitation. The authors will attempt to indicate several of these for the interested reader. Finally, an appendix is provided for a brief review of two-frequency chorus and some current problems with that topic*(B.T. Tsurutani (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA);**G. S. Lakhina**; O. P. Verkhoglyadova (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA)).*

Theoretical analysis of Poynting flux and polarization for ELF-VLF electromagnetic waves in the Earth's magnetosphere

The properties of extremely low-frequency (ELF) and very low-frequency (VLF) electromagnetic waves in the Earth's magnetosphere are discussed. General expressions for wave magnetic field polarization and for the angle θ_P between the direction of the Poynting flux vector and the ambient magnetic field are derived for low-amplitude (linear) waves taking into account first-order finite gyroradius effects. The wave magnetic field is always in a plane perpendicular to the direction of the wave propagation, and the polarization depends on wave frequency (or wavelength), dispersion, and plasma parameters. In a warm plasma, the Poynting flux is not aligned with the group velocity and generally deviates from the wave propagation direction, except for parallel propagation. Numerical estimates for θ_P and wave polarization are made for plasmaspheric hiss (at L=2, 4, and 6) for typical plasma parameters and for the case of elevated electron temperature (5 keV). The plasmaspheric hiss wave magnetic field is right-hand circularly polarized, except for highly oblique hiss waves which are elliptically polarized. A possible transition to the magnetosonic wave regime at short wavelengths is noted. The maximum Poynting flux angle is ~20°. Estimates for daytime outer zone chorus (L=6) show two regions of oblique Poynting flux corresponding to a low-frequency band ($\omega<\omega_{ce}/2$) and to a high-frequency band ($\omega_{ce}/2<\omega<\omega_{ce}$) where ω and ω_{ce} are the wave frequency and the electron cyclotron frequency, respectively. The wave magnetic field polarization varies from circular to elliptical at shorter wavelengths. In a hot plasma, chorus is elliptically polarized. The maximum θ_P in the low-frequency band is ~20°. θ_P can reach ~60° in the high-frequency band. Present results are consistent with the Poynting flux statistics of Polar measurements*(O. P. Verkhoglyadova, B. T. Tsurutani (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA);**G. S. Lakhina**).*

Extremely intense ELF magnetosonic waves: A survey of polar observations

A Polar magnetosonic wave (MSW) study was conducted using 1 year of 1996–1997 data (during solar minimum). Waves at and inside the plasmasphere were detected at all local times with a slight preference for occurrence in the midnight-postmidnight sector. Wave occurrence (and intensities) peaked within~±5° of the magnetic equator, with half maxima at ~±10°. However, MSWs were also detected as far from the equator as +20° and 60° MLAT but with lower intensities. An extreme MSW intensity event of amplitude B_w = ~± 1 nT and E_w = ~± 25 mV/m was detected. This event occurred near local midnight, at the plasmapause, at the magnetic equator, during an intense substorm event, e.g., a perfect occurrence. These results support the idea of

generation by protons injected from the plasma sheet into the midnight sector magnetosphere by substorm electric fields. MSWs were also detected near noon (1259 MLT) during relative geomagnetic quiet (low AE). A possible generation mechanism is a recovering/expanding plasmasphere engulfing preexisting energetic ions, in turn leading to ion instability. The wave magnetic field components are aligned along the ambient magnetic field direction, with the wave electric components orthogonal, indicating linear wave polarization. The MSW amplitudes decreased at locations further from the magnetic equator, while transverse whistler mode wave amplitudes (hiss) increased. It is argued that intense MSWs are always present somewhere in the magnetosphere during strong substorm/convection events. It is thus suggested that modelers use dynamic particle tracing codes and the maximum (rather than average) wave amplitudes to simulate wave-particle interactions*(B.T. Tsurutani, B. J. Falkowski (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA); J. S. Pickett (Physics and Astronomy, University of Iowa, Iowa City, Iowa, USA); O. P. Verkhoglyadova (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA); O. Santolik (Institute of Atmospheric Physics, ASCR, Prague, Czech Republic);**G. S. Lakhina**).*

Low latitude whistlers and conjugate source lightning discharges

One-to-one relation with its causative lightning discharges and propagation features of night-time whistlers recorded at low-latitude station, Allahabad (geomag. lat. 16.05°N, *L* = 1.08), India, from continuous observations made during 1–7 April, 2011 have been studied. The whistler observations were made using the Automatic Whistler Detector (AWD) system and AWESOME VLF receiver. The causative lightning strikes of whistlers were checked in data provided by World-Wide Lightning Location Network (WWLLN). A total of 32 whistlers were observed out of which 23 were correlated with their causative lightnings in and around the conjugate location (geom. lat. 9.87°S) of Allahabad. A multi-flash whistler is also observed on 1 April with dispersions 15.3, 17.5 and 13.6 $s^{1/2}$. About 70% (23 out of 32) whistlers were correlated with the WWLLN detected causative lightnings in the conjugate region which supports the ducted mode of propagation at low latitude. The multi-flash and short whistlers also propagated most likely in the ducted mode to this station **(Figs.7,8,9)** *(P. R. Srivastava (Banaras Hindu University, Varanasi);**S. A. Gokani, A. K. Maurya, R. Singh**; Sushil Kumar (The University of South Pacific, Fiji);**B. Veenadhari, R. Selvakumaran**; A. K. Singh*

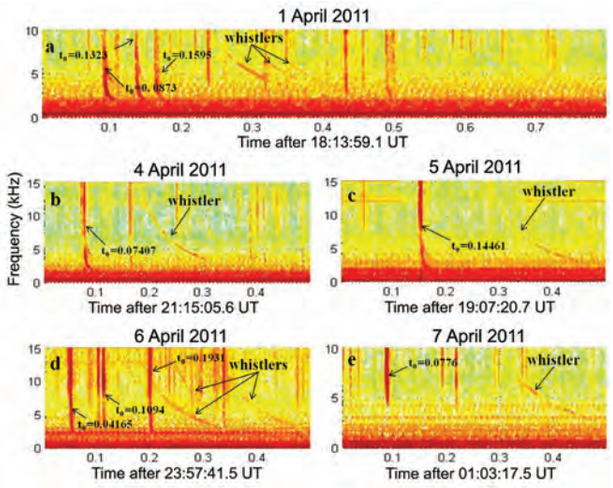


Figure 7

Dynamic spectra of the whistlers observed on (a) 1 April 2011 (triplet), (b) 4 April 2011, (c) 5 April 2011, (d) 6 April 2011, (e) short whistler observed on 7 April 2011.

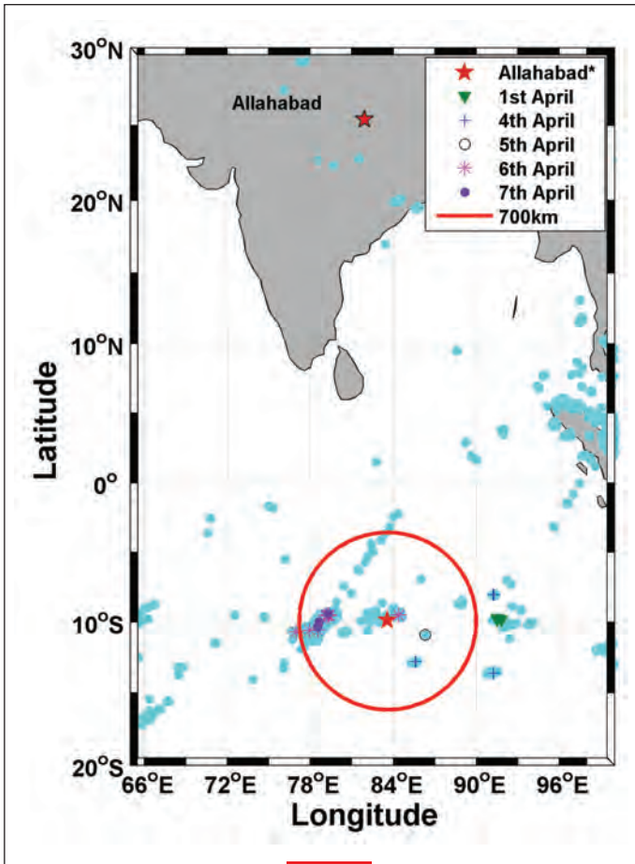


Figure 8

WWLLN detected lightning locations at conjugate region (circle of 700 km radius) of Allahabad for whistlers observed during 1–7 April 2012.

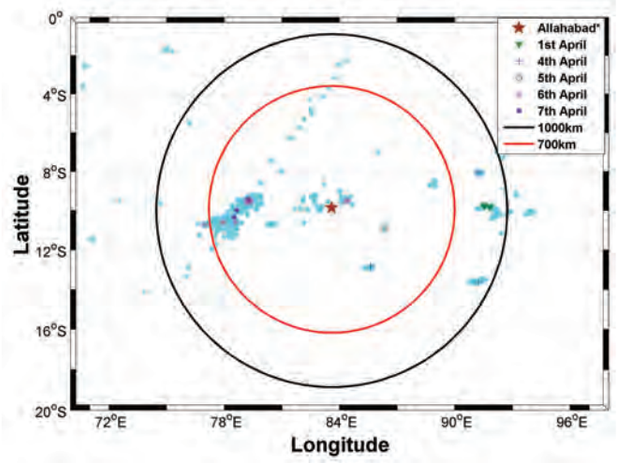


Figure 9

Zoom in plot of WWLLN lightning detection shown in Figure 8 within circles of 700 and 1000 km around the conjugate point.

(Banaras Hindu University, Varanasi);Devendraa Siingh (Indian Institute of Tropical Meteorology, Pune); J. Lichtenberger (Eötvös University, Hungary)).

Solar Flare induced D-region ionospheric perturbations

The results of very low frequency (VLF) wave amplitude measurements carried out at the low latitude station Varanasi (geom. lat. $14^0 55'$ N, long. 154^0 E), India during solar flares were studied. The VLF waves (19.8 kHz) transmitted from the NWC-transmitter Australia and recorded at Varanasi is used in present study. Data are analyzed and the reflection height H′and the sharpness factor *β of D-region ionosphere were* evaluated. It is found that the reflection height decreases whereas sharpness factor increases with the increase of solar flare power. The H′is found to be higher and *β* smaller at low latitudes than the corresponding values at mid and high latitudes. The sunspot numbers were low during the considered period 2011–2012, being the rising phase of solar cycle 24 and as a result cosmic rays may impact the D-region ionosphere. The increased ionization from the flare lowers the effective reflecting height, H′of the D-region roughly in proportion to the logarithm of the X-ray flare intensity from a typical mid-day unperturbed value of about 71–72 km down to about 65 km for an X class flare. The sharpness (*β*) of the lower edge of the D-region is also significantly increased by the flare but reaches a clear saturation value of about 0.48 km−1 for flares of magnitude greater than about X1 class *(As. K. Singh, A.K. Singh (BHU, Varanasi);* ***Rajesh Singh****; R.P. Singh (BHU, Varanasi)).*

Automatic Whistler Detector (AWD) at Low Latitude Indian Stations

At three Indian low latitude stations: Varanasi (geomag. lat. $14^0 55'$ N, geomag. long. $153^0 54'$ E, L: 1.078), Allahabad (geomag. lat. 16.05^0 N; geomag. long. 155.34^0 E, L: 1.081) and Lucknow (geomag. lat. 17.6^0 N, geomag. long. 154.5^0 E, L: 1.104) an Automatic Whistler Detector (AWD) was installed in December, 2010 for detection and analysis of whistlers during CAWSES India phase-II program. This instrument automatically detects and collects statistical whistler data for the investigation of whistler generation and propagation. Large numbers of whistlers have been recorded at Varanasi and Allahabad during the year 2011 which is analyzed in the present study. Different types of whistlers have been recorded at Varanasi and Allahabad. The correlation between recorded whistlers and causative lightning strikes were analyzed using data provided by World-Wide Lightning Location Network (WWLLN). It is observed that for both the stations more than 50% of causative sferics of whistlers was observed to match closely with the times of WWLLN detected lightning strikes within the propagation times of causative tweeks. All of these lightning strikes originated from the region within 500–600km radius circle from the conjugate point of Varanasi and Allahabad supports the ducted propagation at low latitude stations. The dispersion of the observed whistlers varies between 8 and 18 $s^{1/2}$, which shows that the observed whistlers have propagated in ducted mode and whole propagation path of whistlers lies in the ionosphere. The ionospheric columnar electron contents of these observed whistlers vary between 13.21 TECU and 56.57 TECU. The ionospheric parameters derived from whistler data at Varanasi compare well with the other measurements made by other techniques *(Abhay K. Singh, S. B. Singh (BHU, Varanasi);* ***Rajesh Singh, Sneha A. Gokani****; Ashok K. Singh (Lucknow University); Devendraa Siingh (IITM, Pune); Janos Lichtenberger (Etvos University, Hungary)).*

Response of low latitude D-region ionosphere to the total solar eclipse of 22 July 2009

Response of the D-region of the ionosphere to the total solar eclipse of 22 July 2009 at low latitude, Varanasi (Geog. lat., 25.27° N; Geog. long., 82.98° E; Geomag. lat. = 14° 55' N) was investigated using ELF/VLF radio signal. Tweeks, a naturally occurring VLF signal and radio signals from various VLF navigational transmitters are first time used simultaneously to study the effect of total solar eclipse (TSE). Tweeks occurrence is a nighttime phenomena but the obscuration of solar disc during TSE in early morning leads

to tweek occurrence. The changes in D-region ionospheric VLF reflection heights (h) and electron density (n_e: 22.6–24.6 cm^{-3}) during eclipse have been estimated from tweek analysis. The reflection height increased from ~89 km from the first occurrence of tweek to about ~93 km at the totality and then decreased to ~88 km at the end of the eclipse, suggesting significant increase in tweek reflection height of about 5.5 km during the eclipse. The reflection heights at the time of totality during TSE are found to be less by 2–3 km as compared to the usual nighttime tweek reflection heights. This is due to partial nighttime condition created by TSE. A significant increase of 3 dB in the strength of the amplitude of VLF signal of 22.2 kHz transmitted from JJI-Japan is observed around the time of the total solar eclipse (TSE) as compared to a normal day. The modeled electron density height profile of the lower ionosphere depicts linear variation in the electron density with respect to solar radiation as observed by tweek analysis also. These low latitude ionospheric perturbations on the eclipse day are discussed and compared with other normal days *(As. K. Singh (Banaras Hindu University, Varanasi);**Rajesh Singh, B. Veenadhari;** Abhay. K. Singh (Banaras Hindu University, Varanasi)).*

MODELING STUDIES

Cross-field diffusion of energetic (100 keV to 2 MeV) protons in interplanetary space

Magnetic field magnitude decreases (MDs) are observed in several regions of the interplanetary medium. In this paper, MDs observed by the Ulyses spacecraft instrumentation over the solar South pole were characterized by using magnetic field data to obtain the empirical size, magnetic field MD, and frequency of occurrence distribution function. The interaction of energetic (100 keV to 2 MeV) protons with these MDs is investigated. Charged particle and MD interactions can be described by a geometrical model allowing the calculation of the guiding center shift after each interaction. Using the distribution functions for the MD characteristics, Monte Carlo simulations are used to obtain the cross-field diffusion coefficients as a function of particle kinetic energy. It is found that the protons under consideration cross-field diffuse at a rate of up to ≈11% of the Bohm rate. The same method used in this paper can be applied to other space regions where MDs are observed, once their local features are well known*(Jr. E. Costa (Instituto Federal de Minas Gerais-IFMG, Ouro Preto, Brazil); B. T. Tsurutani (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, USA); M. V. Alves, E. Echer (Instituto Nacional de Pesquisas Espaciais-INPE, Sao Jos'dos Campos, Brazil);**G. S. Lakhina**).*

LINEAR AND NON-LINEAR WAVES

Effect of hot ion temperature on obliquely propagating ion-acoustic solitons and double layers in auroral plasma

Properties of obliquely propagating ion-acoustic solitons and double layers in a magnetized auroral plasma composed of hot adiabatic ions and two types of, cool and hot Maxwellian electrons are studied using Sagdeev pseudo-potential technique and assuming the quasi-neutrality condition. The new and surprising result which emerges from the model is that in contrast to the case of cold ions where ion-acoustic solitons and double layers are found for subsonic Mach numbers only, the hot ions case allows these nonlinear structures to exist for both subsonic and supersonic Mach number regimes. The double layers exist at lower angle of propagation as hot ion temperature is increased. The soliton electric field amplitudes are increased but their width and pulse duration are decreased with the increase in hot ion temperature. For the auroral zone parameters, the maximum electric field amplitude, width, pulse duration and speed for the solitons come out to be in the range ~ (0.3–15) mV/m, ~ (195–455) m, (7–20) ms and (22–26) km/s, respectively. The results seem to be in agreement with the Viking satellite observations in the auroral zone *(O.R. Rufai, R. Bharuthram (University of the Western Cape, Bellville, South-Africa);* ***S. V. Singh****,* ***G. S. Lakhina****).*

Existence domains of dust-acoustic solitons and supersolitons

Using the Sagdeev potential method, the existence of large amplitude dust-acoustic solitons and supersolitons is investigated in plasma comprising cold negative dust, adiabatic positive dust, Boltzmann electrons, and non-thermal ions. This model supports the existence of positive potential supersolitons in a certain region in parameter space in addition to regular solitons having negative and positive potentials. The lower Mach number limit for supersolitons coincides with the occurrence of double layers whereas the upper limit is imposed by the constraint that the adiabatic positive dust number density must remain real valued. The upper Mach number limits for negative potential (positive potential) solitons coincide with limiting values of the negative (positive) potential for which the negative (positive) dust number density is real valued. Alternatively, the existence of positive potential solitons can terminate when positive potential double layers occur **(Fig.10)** *(S.K. Maharaj (SANSA Space Science, South Africa); R. Bharuthram (University of*

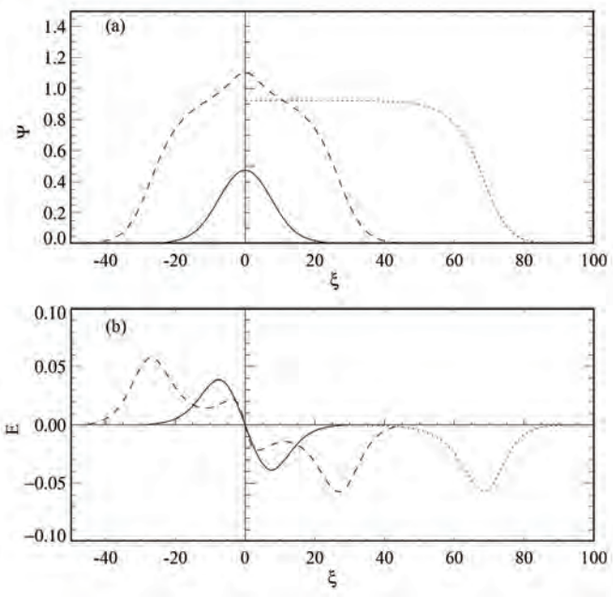


Figure 10

a) Potential and (b) electric field profiles as a function of ξ. The curves correspond to Mach number, M=1.63 (--, solitons), M=1.66821887452588 (……., double layers) and M=1.669 (- -, Supersolitons).

*the Western Cape, Belville, South Africa);**S.V. Singh, G. S. Lakhina**).*

Effect of ion temperature on ion-acoustic solitary waves in magnetized plasma in presence of superthermal electrons

Obliquely propagating ion-acoustic soliatry waves are examined in a magnetized plasma composed of kappa distributed electrons and fluid ions with finite temperature. The Sagdeev potential approach is used to study the properties of finite amplitude solitary waves. Using a quasi-neutrality condition, it is possible to reduce the set of equations to a single equation (energy integral equation), which describes the evolution of ion-acoustic solitary waves in magnetized plasmas. The temperature of warm ions affects the speed, amplitude, width, and pulse duration of solitons. Both the critical and the upper Mach numbers are increased by an increase in the ion temperature. The ion-acoustic soliton amplitude increases with the increase in superthermality of electrons. For auroralplasma parameters, the model predicts the soliton speed, amplitude, width, and pulse duration, respectively, to be in the range of (28.7–31.8) km/s, (0.18–20.1) mV/m; (590–167) m, and (20.5–5.25) ms, which are in good agreement with Viking observations*(**S. V. Singh, S. Devanandhan, G. S. Lakhina**; R. Bharuthram (University of the Western Cape, Bellville, South Africa)).*

Ion acoustic soliton chain formation and validation of nonlinear fluid theory

One-dimensional fluid simulation of ion acoustic (IA) solitons propagating parallel to the magnetic field in electron-ion plasmas by assuming a large system length was performed. To model the initial density perturbations (IDP), a KdV soliton type solution was employed. Simulation demonstrates that the generation mechanism of IA solitons depends on the wavelength of the IDP. The short wavelength IDP evolve into two oppositely propagating identical IA solitons, whereas the long wavelength IDP develop into two indistinguishable chains of multiple IA solitons through a wave breaking process. The wave breaking occurs close to the time when electrostatic energy exceeds half of the kinetic energy of the electron fluid. The wave breaking amplitude and time of its initiation are found to be dependent on characteristics of the IDP. The strength of the IDP controls the number of IA solitons in the solitary chains. The speed, width, and amplitude of IA solitons estimated during their stable propagation in the simulation are in good agreement with the nonlinear fluid theory.This fluid simulation is the first to confirm the validity of the general nonlinear fluid theory, which is widely used in the study of solitary waves in laboratory and space plasmas **(Figs. 11,12)** *(**A. Kakad**; Y. Omura (Research Institute for*

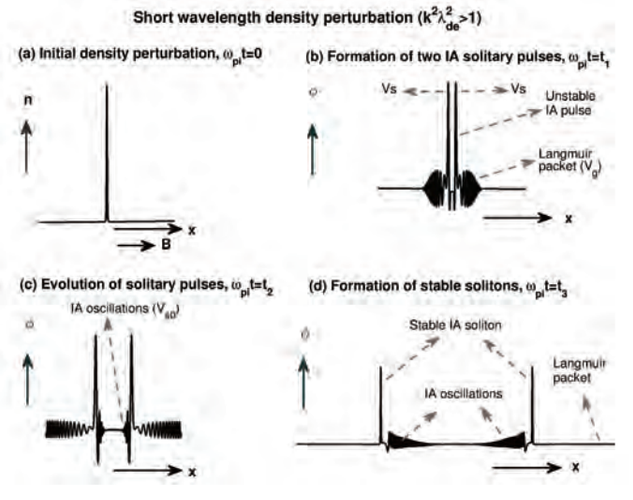


Figure 11

Schematic diagrams showing some of the steps during formation and evolution of IA pulses for the case of short wavelength IDP.

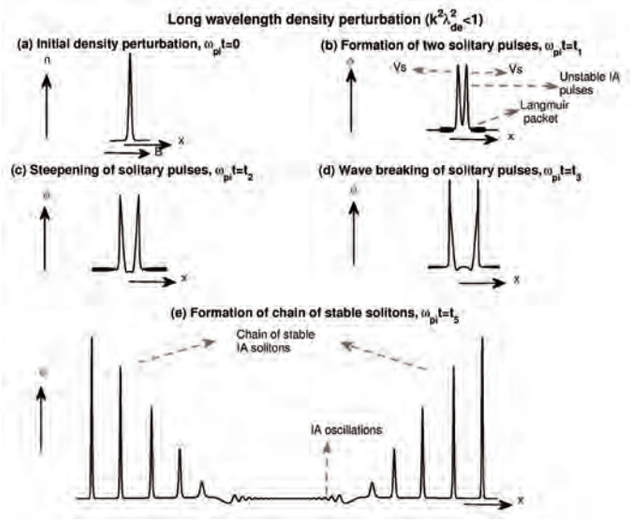


Figure 12

Schematic diagrams illustrate some of the steps during formation and evolution of chains of multiple IA solitons in case of long wavelength IDP

Sustainable Humanosphere, Kyoto University, Japan); ***B. Kakad****).*

Ion temperature anisotropy instabilities in planetary magnetosheaths

There has been a lack of understanding why mirror modes are present in planetary magnetosheaths, at comets, and in the heliosheath. Linear theory indicates that the ion cyclotron instability should dominate over the mirror mode instability in electron-proton plasma.The role of plasma electron temperature anisotropy on the ion cyclotron and mirror mode instabilities is examined. It is shown that an inclusion of anisotropic electrons with $T_{\perp e}/T_{\parallel e} \geq 1.2$ reduces the ion cyclotron growth rate substantially and increases the mirror mode growth rate. The minimum plasma beta for mirror instability dominance (over the ion cyclotron instability) is $\beta_p = 0.5$ *(**B. Remya, R. V. Reddy**; B. T. Tsurutani (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA);* ***G. S. Lakhina****; E. Echer (Instituto Nacional de Pesquisas Espaciais (INPE), São Jose dos Campos, Brazil)).*

Stability of a Compressible Axial Flow with an Axial Magnetic Field

The stability problem of inviscid compressible axial flows with axial magnetic fields is considered. A numerical study of the stability of some basic flows has been carried out and it is found that an increase in the magnetic field strength has a stabilizing effect on subsonic flows and a destabilizing effect on supersonic flows. An analytical study of the stability problem has also been done, but this analytical study is restricted by the approximation M<<1 and c_i<<1, where M is the Mach number and c_i is the imaginary part of the complex phase velocity c. A semicircular region depending on the magnetic field parameter and the Mach number is found for subsonic disturbances and as a consequence it is found that sufficiently strong magnetic field stabilizes all subsonic disturbances. Under a weak magnetic field, it is shown that short subsonic disturbances are stable *(M. Subbaiah (Department of Mathematics, Pondicherry University, Pondicherry);* ***M. S. Anil Iype****).*

Study of magnetosonic waves in an anti-loss cone plasma

The stability of magnetosonic wave in a plasma, where the ions and electrons are described by anti-loss cone (ALC) distributions have been studied. Studies indicate that the magnetosonic waves produced by ions and electrons with ALC distributions are in the higher frequency end within the range of frequencies, as observed by the Combined Release and Radiation Effects Satellite spacecraft. They are weakly damped and can, therefore, travel long distances. These waves are expected to play an important role in the acceleration of radiation belt electrons *(C. Venugopal, S. George, V. R. Rajeev, R. Jayapal (School of Pure and Applied Physics, Mahatma Gandhi University, Kottayam); M. J. Kurian (Catholicate College, Mahatma Gandhi University, Pathnamthitta);* ***C. P. Anil Kumar****).*

Ion-acoustic instabilities in multi-ion plasma

The stability of the ion-acoustic wave in a plasma composed of hydrogen, positively and negativelycharged oxygen ions, and electrons, which approximates very well the plasma environment around a comet have been studied. Modelling each cometary component (H+, O+, and O−) by a ring distribution, it is found that ion-acoustic waves can be generated at frequencies comparable to the hydrogen ion plasma frequency. The dispersion relation has been solved both analytically and numerically. The ratio of the ring speed ($u_{per}s$) to the thermal spread (Vts) modifies the dispersion characteristics of the ion-acoustic wave. The contrasting behaviour of the phase velocity of the ion-acoustic wave in the presence of O− ions for $u_{per}s$>Vts (and vice versa) can be used to detect the presence of negatively charged oxygen ions and also their thermalization *(Noble P. Abraham, Sijo Sebastian, G. Sreekala, R. Jayapal (School of Pure and Applied Physics, Mahatma Gandhi University, Kottayam);****C. P. Anil Kumar****;Venugopal Chandu (School of Pure and Applied Physics, Mahatma Gandhi University, Kottayam)).*

CRUSTAL AND DEEP CONTINENTAL RESEARCH

GEOPOTENTIAL STUDIES

Aeromagnetic signatures of Precambrian shield and suture zones of Peninsular India

In many Precambrian provinces the understanding of the tectonic history is constrained by limited exposure and aeromagnetic data provide information below the surface cover of sediments, water, etc.and help build a tectonic model of the region. The advantage of using the aeromagnetic data is that the data set has uniform coverage and is independent of the accessibility of the region. In the present study, available reconnaissance scale aeromagnetic data over Peninsular India are analyzed to understand the magnetic signatures of the Precambrian shield and suture zones thereby throwing light on the tectonics of the region. Utilizing a combination of differential reduction to pole map, analytic signal, vertical and tilt derivative and upward continuation maps, the magnetic source distribution, tectonic elements, terrane boundaries, suture zones and metamorphic history of the region could be identified. The magnetic sources in the region are mainly related to charnockites, iron ore and alkaline intrusives. Analysis of data suggests that the Chitradurga boundary shear and Sileru shear are terrane boundaries while the signatures of Palghat Cauvery and Achankovil shears are interpreted to represent suture zones. Processes like metamorphism leave their signatures on the magnetic data: progradegranulites (charnockites) and retrograde eclogites are known to have high susceptibility. It is found that charnockites intruded by alkali plutons have higher magnetization compared to the retrogressed charnockites. It is further interpreted that the Dharwar craton to the north of isograd representing greenschist to amphibolite facies transition, has been subjected to metamorphism under low geothermal conditions. Some recent studies suggest a plate tectonic model of subduction-collision-accretion tectonics around the Palghat Cauvery shear zone (PCSZ). Further analysis is able to identify several west to east trending high amplitude magnetic anomalies with deep sources in the region from Palghat Cauvery shear to Achankovil shear. The magnetic high associated with PCSZ may represent the extruded high pressure-ultra high temperature metamorphic belt (granulites at shallow levels and retrogressed eclogites at deeper levels) formed as a result of subduction process. The EW highs within the

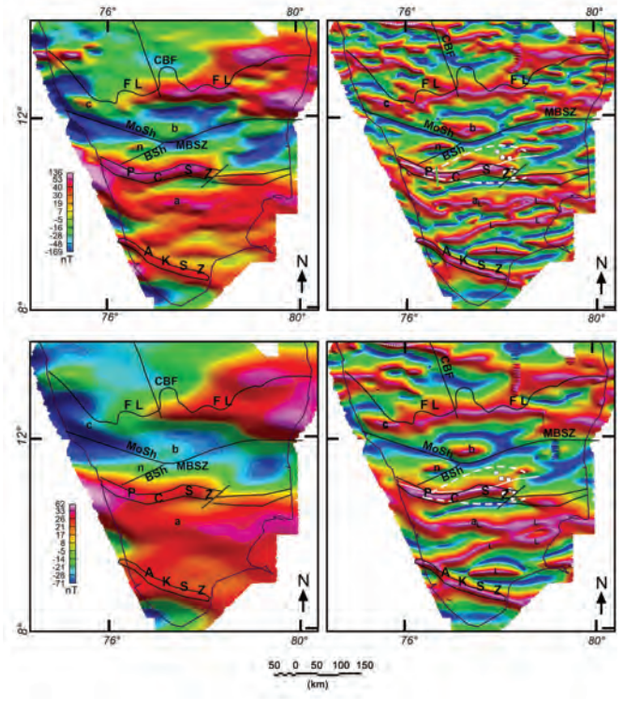


Figure 13

Differential Reduced to Pole (DRTP) map of aeromagnetic data of Southern Granulite Terrain upward continued to: (a) 10 km, (c) 30 km and its tilt derivative (b, d).CBF- Chitradurga Boundary Fault, FL-Fermor line, MoSh-Moyar shear zone, BSh-Bhavani shear, MBSZ-Moya Bhavani Shear Zone PCSZ-Palghat Cauvery shear zone, AKSZ-Achankovil shear zone. Hills: c-Coorg, b-Biligirirangan, n-Nilgiri, a-Anamalai. White dotted lines and white filled circles (in c and d) represent the location of the mapped core of orogen and the high pressure ultra high temperature (HPeUHT) granulites.

Madurai block can be related to the metamorphosed clastic sediments, BIF and mafic/ultramafic bodies resulting from the process of accretion **(Fig.13)** ***(M. Rajaram, S.P. Anand)***.

Tectonic framework of Laccadive Ridge in Western Continental Margin of India

From the analysis of the satellite derived high resolution free air gravity data it is inferred that the evolutionary history of the Western Continental Margin of India to north and south of Goa appears to be totally different. The shelf edge is continuous and not disturbed in the northern part whereas to the south (south of 16°N) it has been affected by the onshore tectonics. It is hotly debated if the Laccadive Ridge (northern part of the Chagos-Laccadive Ridge) is continental or oceanic in nature or just of volcanic origin. From the filtered

maps of the free air gravity anomalies, sources at different depths can be deciphered that help build an evolutionary model of the much debated Laccadive Ridge. The lowpass filtered maps depicting deeper features, show a persistence of NW–SE to NS Dharwarian trends and it appears that the Laccadive Ridge to the north of around 8.5°N is of continental origin being bounded to the south and north by the offshore extension of the Bhavani Shear and Chapporo lineament respectively. It may have separated from India along with Madagascar during Cretaceous. At the Cretaceous Tertiary boundary as Laccadive-India passed over the Reunion hotspot, the pre-existing faults on the Laccadive Ridge were re-activated and the hotspot trace was left behind in the intermediate/shallow wavelength of the anomalies, as intrusives in the Laccadive Ridge. These are reflected in the high-pass filtered maps, depicting shallow to intermediate wavelength anomalies, which show NE–SW structures. The crustal structure derived from the 2D model of the satellite derived free air gravity data and a representative gravity-magnetic profile from ship borne data also depict continental nature of the Laccadive Ridge with emplacement of volcanic intrusive as it passed over the Reunion hotspot **(Fig.14)** ***(N. Nair, S.P. Anand, M. Rajaram)***.

Depth to the bottom of magnetic sources (DBMS) from aeromagnetic data of central India using modified centroid method for fractal distribution of sources

The depth to the bottom of the magnetic sources (DBMS) has been estimated from the aeromagnetic data of central India. The conventional centroid method of DBMS estimation assumes random uniform uncorrelated distribution of sources and to overcome this limitation a modified centroid method based on scaling distribution has been proposed. Shallower values of the DBMS are found for the south-western region. The DBMS values are found as low as 22 km in the south-west Deccan trap covered regions and as deep as 43 km in

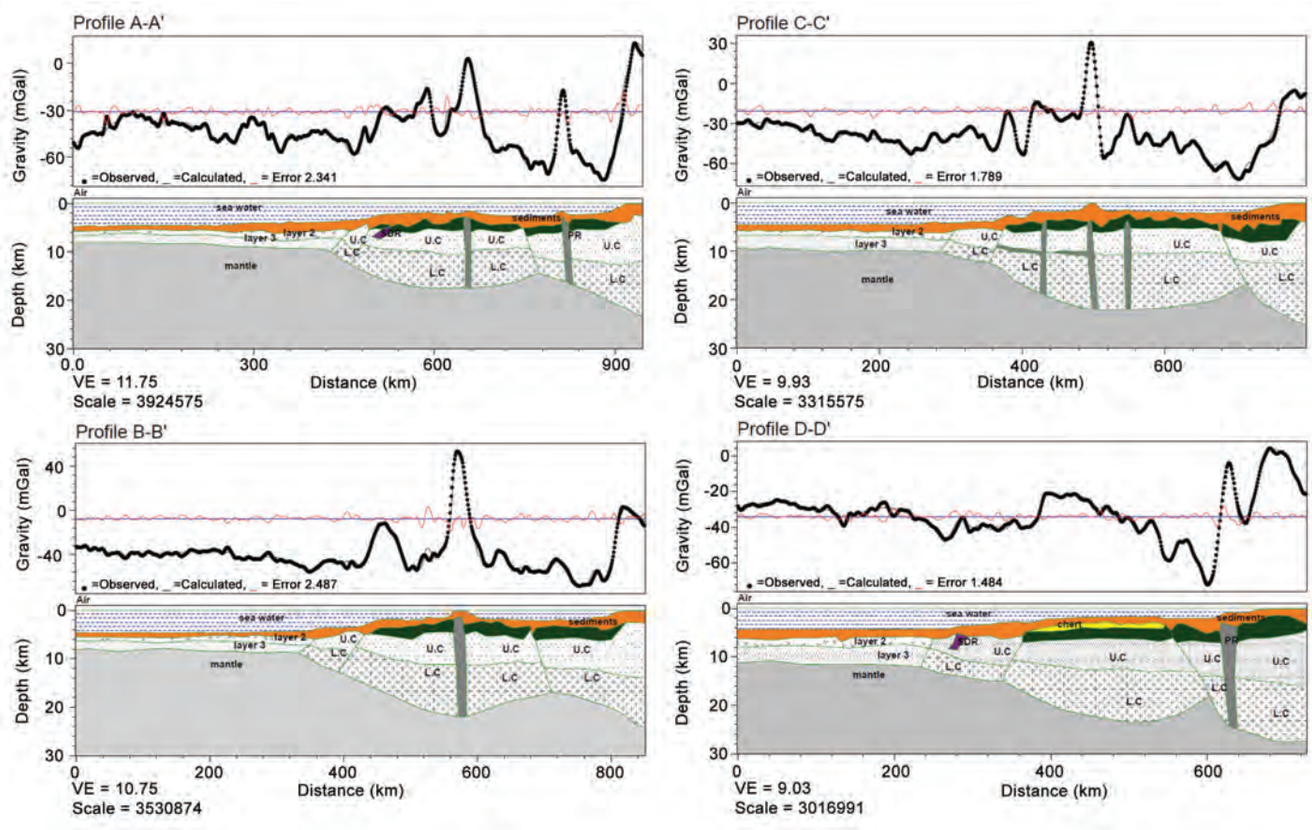


Figure 14

Crustal model derived from the free air gravity data analysis along four profiles A–A′, B–B′, C–C′ and D–D′ across Laccadive ridge. The water depths and sediment thickness have been obtained from the bathymetry and isopach maps. Dotted lines represent the observed values while the full lines depict the calculated values and the thin red lines depict the errors. The inferred OCB is shown by a bold arrow in each profile.

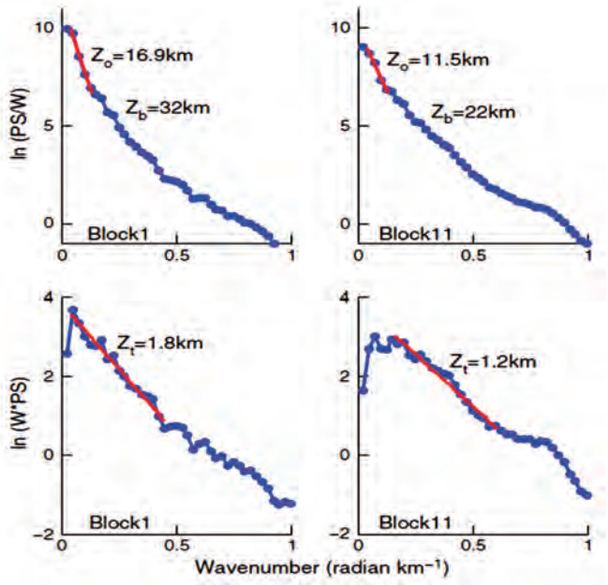


Figure 15

Spectral depth estimates for two representative block (200km X 200km) of aeromagnetic data over Central Indian region. The lower figure indicates depth to top of the magnetic sources (Z_t) estimated from power spectral methods. Upper portion depicts the estimated centriod depth (Z_o) and depth to bottom of magnetic source (Z_b) calculated suing modified centroid method assuming fractal distribution of magnetic sources.

the Chhattisgarh Basin. In most of the places DBMS are much shallower than the Moho depth, earlier found from the seismic study and may be representing the thermal/ compositional/petrological boundaries.The large variation in the DBMS indicates the complex nature of the Indian crust **(Fig.15)** *(A.R. Bansal (CSIR-NGRI, Hyderabad);* ***S.P. Anand, M. Rajaram****; V.K. Rao, V.P. Dimri (CSIR-NGRI, Hyderabad)).*

Proterozoic orogenic belts and rifting of Indian cratons: Geophysical constraints

The Aravalli Delhi and Satpura Mobile Belts (ADMB and SMB) and the Eastern Ghat Mobile Belt (EGMB) in India form major Proterozoic mobile belts with adjoining cratons and contemporary basins. The most convincing features of the ADMB and the SMB have been the crustal layers dipping from both sides in opposite directions, crustal thickening (~45 km) and high density and high conductivity rocks in upper/ lower crust associated with faults/thrusts. These observations indicate convergence while domal type reflectors in the lower crust suggest an extensional rifting phase. In case of the SMB, even the remnant of the subducting slab characterized by high conductive and low density slab in lithospheric mantle up to ~120 km across the Purna-Godavari river faults has been traced which may be caused by fluids due to metamorphism. Subduction related intrusives of the SMB south of it and the ADMB west of it suggest N-S and E-W directed convergence and subduction during Meso-Neoproterozoic convergence. The simultaneous E-W convergence between the Bundelkhand craton and Marwar craton (western Rajasthan) across the ADMB and the N-S convergence between the Bundelkhand craton and the Bhandara and Dharwar cratons across the SMB suggest that the forces of convergence might have been in a NE-SW direction with E-W and N-S components in the two cases, respectively. This explains the arcuate shaped collision zone of the ADMB and the SMB which are connected in their western part. The Eastern Ghat Mobile Belt (EGMB) also shows signatures of E-W directed Meso-Neoproterozoic convergence with east Antarctica similar to ADMB in north India. Foreland basins such as Vindhyan (ADMB-SMB) and Kurnool (EGMB) Supergroups of rocks were formed during this convergence. Older rocks such as Aravalli (ADMB), Mahakoshal-Bijawar (SMB), and Cuddapah (EGMB) Supergroups of rocks with several basic/ultrabasic intrusives along these mobile belts, plausibly formed during an earlier episode of rifting during Paleo-Mesoproterozoic period. They are highly disturbed and deformed due to subsequent Meso-Neoproterozoic convergence. As these Paleoproterozoic basins are characterized by large scale basic/ultrabasic intrusive that is considerably wide spread, it is suggested that a plume/superplume might have existed under the Indian cratons at that time which was responsible for the breakup of these cratons. Further, the presence of older intrusives in these mobile belts suggests that there might have been some form of convergence also during Paleoproterozoic period *(D.C. Mishra (CSIR-NGRI, Hyderabad);* ***M. Ravi Kumar****).*

Lithosphere, crust and basement ridges across Ganga and Indus basins and seismicity along the Himalayan front, India and Western Fold Belt, Pakistan

Spectral analysis of the digital data of the Bouguer anomaly of north India including Ganga basin suggest a four layer model with approximate depths of 140, 38, 16 and 7 km. They apparently represent lithosphere–asthenosphere boundary (LAB), Moho, lower crust, and maximum depth to the basement in foredeeps, respectively. The Airy's root model of Moho from the topographic data and modeling of Bouguer anomaly constrained from the available seismic information suggest changes in the lithospheric and crustal thicknesses from ~126–134 km and ~32–35 km under the central Ganga basin to ~132 and ~38 km towards the south and 163 and ~40 km towards the north, respectively. It has clearly brought out the lithospheric flexure and related crustal

bulge under the Ganga basin due to the Himalaya. Airy's root model and modeling along a profile (SE–NW) across the Indus basin and the Western Fold Belt (WFB), (Sibi Syntaxis, Pakistan) also suggest similar crustal bulge related to lithospheric flexure due to the WFB with crustal thickness of 33 km in the central part and 38 and 56 km towards the SE and the NW, respectively. It has also shown high density lower crust and Bela ophiolite along the Chamman fault. The two flexures interact along the Western Syntaxis and Hazara seismic zone where several large/great earthquakes including 2005 Kashmir earthquake was reported.The residual Bouguer anomaly maps of the Indus and the Ganga basins have delineated several basement ridges whose interaction with the Himalaya and the WFB, respectively have caused seismic activity including some large/great earthquakes. Some significant ridges across the Indus basin are (i) Delhi–Lahore–Sargodha, (ii) Jaisalmer–Sibi Syntaxis which is highly seismogenic and (iii) Kachchh–Karachi arc–Kirthar thrust leading to Sibi Syntaxis. Most of the basement ridges of the Ganga basin are oriented NE–SW that are as follows (i) Jaisalmer–Ganganagar and Jodhpur–Chandigarh ridges across the Ganga basin intersect Himalaya in the Kangra re-entrant where the great Kangra earthquake of 1905 was located. (ii) The Aravalli Delhi Mobile Belt (ADMB) and its margin faults extend to the Western Himalayan front via Delhi where it interacts with the Delhi–Lahore ridge and further north with the Himalayan front causing seismic activity. (iii) The Shahjahanpur and Faizabad ridges strike the Himalayan front in central Nepal that do not show any enhanced seismicity which may be due to their being parts of the Bundelkhand craton as simple basement highs. (iv) The west and the east Patna faults are parts of transcontinental lineaments, such as Narmada–Son lineament. (v) The Munghyr–Saharsa ridge is fault controlled and interacts with the Himalayan front in the eastern Nepal where Bihar–Nepal earthquake of 1934 has been reported. Some of these faults/lineaments of the Indian continent find reflection in seismogenic lineaments of Himalaya like Everest, Arun, Kanchenjunga lineaments. A set of NW–SE oriented gravity highs along the Himalayan front and the Ganga and the Indus basins represents the folding of the basement due to compression as anticlines caused by collision of the Indian and the Asian plates. This study has also delineated several depressions like Saharanpur, Patna, and Purnia depressions ***(M.Ravi Kumar**; D.C.Mishra, B.Singh (CSIR-NGRI, Hyderabad)).*

Long wavelength gravity anomalies over India: Crustal and lithospheric structures and its flexure

Long wavelength gravity anomalies over India were obtained from terrestrial gravity data through two independent methods: (i) wavelength filtering and (ii) removing crustal effects. The gravity fields due to the lithospheric mantle obtained from two methods were quite comparable. The long wavelength gravity anomalies were interpreted in terms of variations in the depth of the lithosphere–asthenosphere boundary (LAB) and the Moho with appropriate densities that are constrained from seismic results at certain points. Modeling of the long wavelength gravity anomaly along a N–S profile (77^0E) suggest that the thickness of the lithosphere for a density contrast of 0.05 g/cm^3 with the asthenosphere is maximum of ~190 km along the Himalayan front that reduces to ~155 km under the southern part of the Ganga and the Vindhyan basins increasing to ~175 km south of the Satpura Mobile belt, reducing to ~155–140 km under the Eastern Dharwar craton (EDC) and from there consistently decreasing southwards to ~120 km under the southernmost part of India, known as Southern Granulite Terrain (SGT). The crustal model clearly shows three distinct terrains of different bulk densities, and thicknesses, north of the SMB under the Ganga and the Vindhyan basins, and south of it the Eastern Dharwar Craton (EDC) and the Southern Granulite Terrain (SGT) of bulk densities 2.87, 2.90 and 2.96 g/cm^3, respectively. It is confirmed from the exposed rock types as the SGT is composed of high bulk density lower crustal rocks and mafic/ultramafic intrusives while the EDC represent typical granite/gneisses rocks and the basement under the Vindhyan and Ganga basins towards the north are composed of Bundelkhand granite massif of lower density. The crustal thickness along this profile varies from ~37–38 km under the EDC, increasing to ~40–45 km under the SGT and ~40–42 km under the northern part of the Ganga basin with a bulge up to ~36 km under its southern part. Reduced lithospheric and crustal thicknesses under the Vindhyan and the Ganga basins are attributed to the lithospheric flexure of the Indian plate due to Himalaya. Crustal bulge due to lithospheric flexure is well reflected in isostatic Moho based on flexural model of average effective elastic thickness of ~40 km. Lithospheric flexure causes high heat flow that is aided by large crustal scale fault system of mobile belts and their extensions northwards in this section, which may be responsible for lower crustal bulk density in the northern part. A low density and high thermal regime in north India, north of the SMB compared to south India, however does not conform to the high S-wave velocity in the northern part and thus it is attributed to changes in composition between the northern and the southern parts indicating a reworked lithosphere. Some of the long wavelength gravity anomalies along the east and the west coasts of India are attributed to the intrusives that caused the breakup of India from Antarctica, and Africa, Madagascar and Seychelles along

the east and the west coasts of India, respectively *(V.M. Tiwari (CSIR-NGRI, Hyderabad); **M. Ravi Kumar**; D.C. Mishra (CSIR-NGRI, Hyderabad)).*

ELECTROMAGNETIC INDUCTION STUDIES

Crustal evolution and tectonics of the Archean Bundelkhand Craton, central India

Magnetotelluric studies over the Bundelkhand craton indicates a high resistivity sub-structure, typically observed in the Archean-Proterozoic regions. The geoelectric section shows a single high resistivity layer in the northern part of the craton, extending from surface to depth of about 60 km and a three layered resistivity structure overlying a conductive bottom in its southern part. The geological studies reported earlier have delineated an EW trending zone of ultramafic rocks, called the Bundelkhand Tectonic zone (BTZ), which marks the divide between the two electrical resistivity patterns. The geoelectric structure is broadly indicative of a northward dipping tectonic fabric in this region which conforms to the Himalayan subduction, to the immediate north of this craton. However this observation cannot explain the findings from geochemical, isotope analysis and geological studies, suggesting possible vertical block movements in the region, which are also indicated in the Bouguer gravity studies. The geoelectric structure beneath the Vindhyan group to the south shows low resistivities even up to 60 km, suggesting that the Bundelkhand craton which is characterized by high resistivity rocks, does not extend to the south beneath the Vindhyans, as was believed by the earlier researchers. A low resistivity body with an extremely high conductance of about 100,000 Siemens is delineated at the mid crustal depths beneath the exposed Bijawars south of Bundelkhand craton. The causative factors behind this low resistivity are not immediately apparent, but some possibilities are discussed *(**S.G. Gokarn, C.K. Rao, C. Selvaraj, G. Gupta, B.P. Singh**).*

GLOBAL POSITIONING SYSTEM AND GEODESY STUDIES

Causative source of Mw 6.9 Sikkim-Nepal border earthquake of September 2011: GPS baseline observations and strain analysis

The recent earthquake of Mw 6.9 which occurred on September 18, 2011 in Sikkim–Nepal border region (epicenter 27.72°N, 88.06°E, depth 20.7 km, ~68 km NW of the Capital city Gangtok) is the strongest earthquake in the instrumentally recorded history of the region. The fault plane solution of this earthquake indicates a strike-slip motion. However, the seismological and geological studies carried out so far after the earthquake could not confirm the causative fault plane. In the present study, GPS observations are used to ascertain causative source in the generation of earthquake and its correlation with the observed seismic data of the region. The co-seismic displacements recorded by GPS show maximum displacement of ~11 mm at Phodong and ~9 mm at Taplejung station, near the epicenter. A simple rigid cross fault model using GPS baseline observations was employed to figure out the causative fault plane and seismological characteristic of the region. It is inferred that the movement represents the kinematic adjustment of the subsidiary faults as a result of the displacement along the NW–SE principal plane. Strain analysis using GPS baseline inferred that the region southeast of epicenter has undergone large deformation. In addition, a significant part of the measured deformation across the surface fault zone for this earthquake can be attributed to post-seismic creep **(Fig.16)** *(R. Pradhan, S. K. Prajapati, S. Chopra, A. Kumar, B. K. Bansal (Seismology Division, MOES, New Delhi); **C. D. Reddy**).*

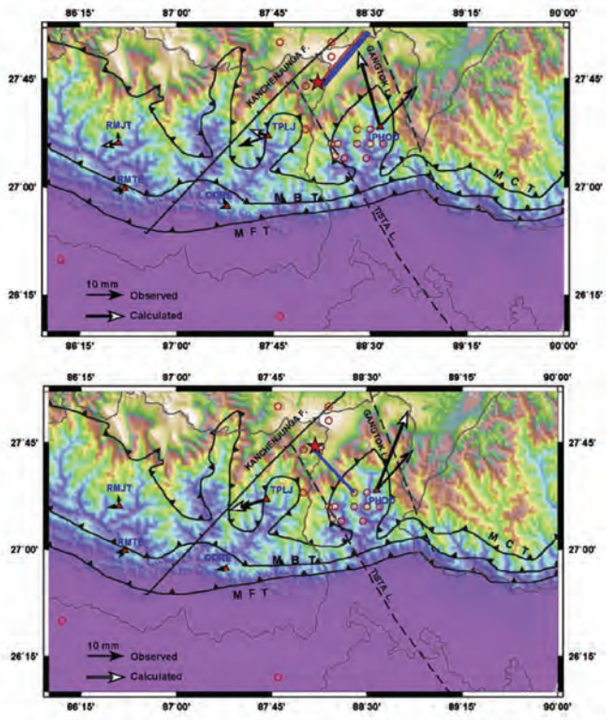


Figure 16

Co-seismic displacements calculated for 18th September 2011 Sikkim Himalaya earthquake. The left and right panel shows the observed and calculated displacement considering NP1 and NP2 fault parameter respectively. Red star shows the location of Sikkim earthquake. The rectangular blue block shows the fault model.

ENVIRONMENTAL AND HYDROGEOPHYSICAL RESEARCH

ENVIRONMENTAL MAGNETISM STUDIES

Physicochemical analyses of surface sediments from the Lonar Lake, central India–implications for palaeoenvironmental reconstruction

Results of the investigations on the catchment area, surface sediments, and hydrology of the monsoonal Lonar Lake, central India indicate that the lake is currently stratified with an anoxic bottom layer, and there is a spatial heterogeneity in the sensitivity of sediment parameters to different environmental processes. In the shallow (0-5 m) near shore oxic-suboxic environments the lithogenic and terrestrial organic content is high and spatially variable, and the organics show degradation in the oxic part. Due to aerial exposure resulting from lake level changes of at least 3 m, the evaporitic carbonates are not completely preserved. In the deep water (> 5 m) anoxic environment the lithogenics are uniformly distributed and the $\delta^{13}C$ is an indicator not only for aquatic vs. terrestrial plants but also of lake pH and salinity. The isotopic composition of the evaporites is dependent not only on the isotopic composition of source water (monsoon rainfall and stream inflow) and evaporation, but is also influenced by proximity to the isotopically depleted stream inflow. It is concluded that in the deep water environment lithogenic content, and isotopic composition of organic matter can be used for palaeoenvironmental reconstruction *(**N.Basavaiah**; M.G. Wiesner, P. Menzel, B. Gaye (Universität Hamburg, Institute of Biogeochemistry and Marine Chemistry, Hamburg, Germany); A. Anoop, N.R. Nowaczyk, R. Naumann, A. Brauer (German Research Center for Geosciences, Telegrafenberg, Potsdam, Germany); **K. Deenadayalan**;N. Riedel (Senckenberg Research Institute, Research Station of Quaternary Palaeontology, Germany); S. Prasad (Institute for Earth- and Environmental Science, University of Potsdam, Potsdam, Germany)).*

Prolonged monsoon droughts and links to Indo-Pacific warm pool: a Holocene record from Lonar Lake, central India

Concerns about global climate change have highlighted the gaps in the Indian Summer Monsoon (ISM) and the absence of long term palaeoclimate data from the central Indian core monsoon zone (CMZ). The multiproxy reconstruction of Holocene palaeoclimate from a 10 m long sediment core raised from the Lonar Lake in central India showed two prolonged droughts (PD) between 4.6–3.9 and 2–0.6 cal ka. A comparison with available data from other ISM influenced sites showed that the impact of these PD coincides with intervals of higher solar irradiance, demonstrating that (i) the regional warming in the Indo-Pacific Warm Pool (IPWP) played an important role in causing ISM PD; (ii) the long term influence of conditions like El Niño-Southern Oscillation (ENSO); (iii) the first settlements in central India coincided with the onset of the first PD and agricultural populations flourished between the two PD, highlighting major environmental factors affecting human settlements*(S. Prasad, A. Anoop(Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Potsdam, Germany); N. Riedel (Senckenberg Research Institute, Research Station of Quaternary Palaeontology, Germany);S. Sarkar (Institute for Earth and Environmental Science, University of Potsdam, Potsdam, Germany); P. Menzel (Universität Hamburg, Institute of Biogeochemistry and Marine Chemistry, Hamburg, Germany));**N. Basavaiah**; R. Krishnan (Indian Institute of Tropical Meteorology, Pune, India); D. Fuller (Institute of Archaeology, University College London, London, UK); B. Plessen(Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Potsdam, Germany); B. Gaye(Universität Hamburg, Institute of Biogeochemistry and Marine Chemistry, Hamburg, Germany); U. Röhl(MARUM – Center for Marine Environmental Sciences, University of Bremen,Germany); H.Wilkes(Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Potsdam, Germany); D. Sachse(Institute for Earth and Environmental Science, University of Potsdam, Potsdam, Germany); R.Sawant, (Deccan College, Post-Graduate and Research Institute, Pune, India);M.G.Wiesner(Universität Hamburg, Institute of Biogeochemistry and Marine Chemistry, Hamburg, Germany);M. Stebich(Senckenberg Research Institute, Research Station of Quaternary Palaeontology, Germany)).*

Spatial heterogeneity in lipid biomarker distributions in the catchment and sediments of a crater lake in central India

The basin-scale spatial variability in lipid biomarker proxies in lacustrine sediments has rarely been examined. The distribution of lipid biomarkers in a modern ecosystem has been evaluated by analyzing lipid biomarkers in lake surface sediments from 17 locations within the saline–alkaline Lonar Crater Lake in central India. Terrestrial vegetation and lake surface sediments were characterized by relatively high average chain length (ACL) index values (29.6–32.8) of leaf wax *n*-alkanes, consistent with suggestions that plants in drier and warmer climates produce longer chain alkyl lipids than plants in cooler and humid areas. A heterogeneous spatial distribution of ACL values in lake surface sediments was found at locations away from the shore, the values were highest (31 or more), possibly indicating different sources and/or transport of terrestrial biomarkers. In floating, benthic

microbial mats and surface sediment, *n*-heptadecane, carotenoids, diploptene, phytol and tetrahymanol occurred in large amounts. Interestingly, these biomarkers of a unique bacterial community were found in substantially higher concentrations in nearshore sediment samples, suggesting that human influence and subsequent nutrient supply resulted in increased primary productivity. In summary, the data showed that substantial heterogeneity existed within the lake, but leaf wax *n*-alkanes in a core from the center of the lake represented an integral of catchment conditions. However, lake level fluctuation may potentially affect aquatic lipid biomarker distributions in lacustrine sediments, in addition to source changes *(S. Sarkar (Institute for Earth- and Environmental Science, University of Potsdam, Germany); H. Wilkes,S. Prasad, A. Brauer (Helmholtz Centre Potsdam GFZ German Research Centre for Geosciences, Germany);N. Riedel,M. Stebich (Senckenberg Research Institute, Germany);* ***N.Basavaiah****; D.Sachse(Institute for Earth- and Environmental Science, University of Potsdam, Germany)).*

Provenance discrimination and source-to-sink studies from a dryland fluvial regime: An example from Kachchh, western India

Tracing the sediment delivery from its source terrain to its ultimate sink envisage multiple factors. Multi-proxy sediment provenance proxies such as grain-size, clay minerals, geochemistry and magnetic minerals have been evaluated here for the provenance discriminating characteristics of the Kachchh dryland fluvial system and factors influencing them. The results of different proxies indicate that the provenance signatures of uplands are quite characteristic with magnetic susceptibility (χ) values of $<20\times10^{-7}$ m^3 kg^{-1} and smectite (S)/kaolinite (K) ratio between 0.26 and 0.49. The middle reaches show marked increase in magnetic mineral concentration with χ values (140×10^{-7} m^3 kg^{-1}) and S/K ratio (4.92), while the estuarine tract shows χ values ($80\times10^{-7}m^3$ kg^{-1}), S/K ratio (1.90) and, characteristic heavy minerals (i.e. mica minerals), probably reflect the interplay between land and sea oscillations. Major sources of sediments within catchment scale were identified, viz., upland sedimentary rocks (Juran and Bhuj Formation sandstone-shale) and middle reaches volcanic (Deccan Trap Formation basalt) rocks. The present study draw cautions in provenance of sediment discrimination in areas influenced by Deccan basalt that has the overwhelming sediment delivery and a comparatively subdued effects of other provenance signatures. The studied proxies of mineralogy of clays, magnetic minerals and geochemistry of heavy and major elements serve as the potential for fingerprint of sediment source regions and hence behold a strong position in source

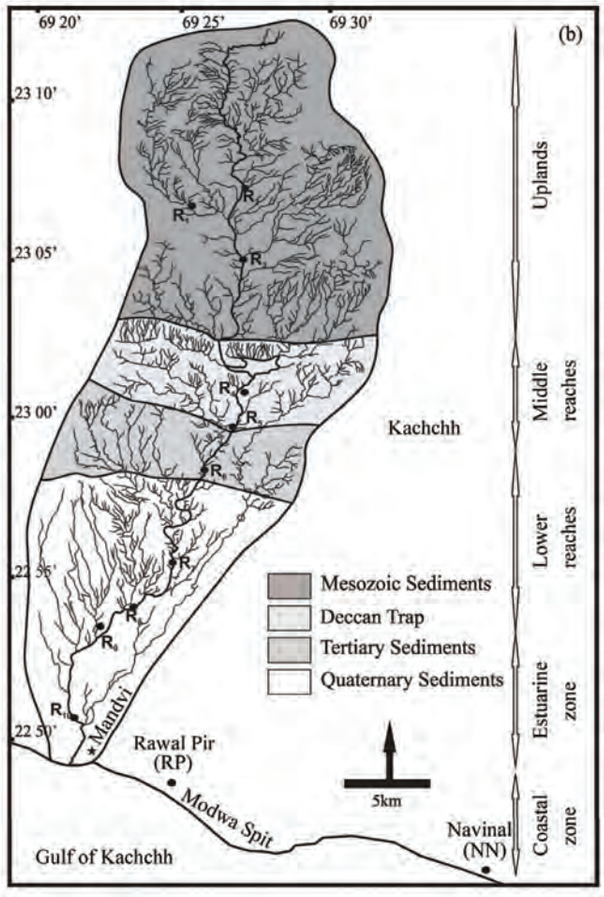


Figure 17

Major geological formations and sampling site locations in Rukmawati river basin of Kachchh mainland, Gujarat.

to sink studies globally **(Fig.17)** *(S.P. Prizomwala (Institute of Seismological Research, Raisan, Gandhinagar); N. Bhatt (Department of Geology, The M. S. University of Baroda, Vadodara);* ***N.Basavaiah****).*

Cation distribution of Cu^{2+} substituted NiZn ferrite

Cation distribution of Cu^{2+} substituted NiZn ferrites having general formula $Ni_{0.5}Cu_{x/2}Zn_{(0.5-x/2)}Fe_2O_4$ (where x = 0.3, 0.4, 0.5, 0.6) were investigated. From proposed cation distribution, it was found that Zn^{2+} occupied A and B site, which replaced Fe^{3+} ions. The distribution was confirmed by theoretical and experimental magnetic moment values as well as by theoretical and experimental lattice parameter values *(N.S. Shinde (D.B.J. College, Chiplun); S.S. Khot (Smt. Chandibai Himathmal Mansukhani College, Ulhasnagar); R.M. More (Centre for Materials for Electronics Technology (C-MET), Pune), B.B. Kale (P.D.Karkhanis College, Ambernath);* ***N.***

***Basavaiah**;S.C. Watawe (S.I.C.E.S. Degree College of Arts, Science and Commerce, Ambernath); M.M. Vaidya (P.D.Karkhanis College, Ambernath)).*

Magnetic and dielectric measurements of Mn substituted $LaFeO_3$ compounds

$LaFeO_3$ is a known orthoferrite which shows multiferroic behaviour and magnetoelectric coupling at room temperature. Data of magnetic and dielectric measurements in Mn substituted $LaFeO_3$ are presented. Samples are prepared using solid state reaction. Weak ferromagnetic behaviour is observed in samples for $LaFeO_3$ and $LaFe_{0.75}Mn_{0.25}O_3$ with orthorhombic structure. Higher Mn concentration(x>0.5) indicate rhombohedral structure and subsequently antiferromagnetic behaviour. Dielectric measurements show that for $LaFe_{0.25}Mn0_{.75}O_3$, dielectric constant has value of order 50 $\times 10^4$ and loss factor value is of the order 50000, whereas for $LaFe_{0.75}Mn_{0.25}O_{3.13}$, the same are 1.15×10^7 and 1400 respectively. The loss factor of these order indicate a leakage phenomenon *(V. Sandeep (S.I.W.S. College,Wadala); **P.K. Das**; H. Muthurajan, S. Radha (University of Mumbai); **N. Basavaiah**).*

Microstructure and infrared absorption spectroscopic study of Zn substituted Li-Cu ferrites

In view of wide ranging applications mixed Lithium Zinc ferrites have been chosen for the present study. An attempt has been made to report the structural properties of Zn substituted Li-Cu ferrite synthesized using microwave induced combustion synthesis route. The ferrites of the composition $Li_xZn_{(0.6-2x)}Cu_{0.4}Fe_2O_4$ (X=0.05, 0.1, 0.15, 0.2, 0.25, 0.3) at different chemical reaction temperature (100 ºC, 125 ºC and 150 ºC) were prepared using non-conventional microwave sintering method. The structural properties and IR absorption spectra were investigated. Lattice parameter, crystalline size, grain size and absorption bands shows variation with Zn concentration. Far infrared absorption spectra show four absorption bands. The grain size is determined using SEM. The average value of the grain size for all the samples is found to be in the 64 nm to 98 nm. The force constants have obtained from the infrared absorption band and their dependence with the internuclear distance has been discussed. The advantage of this method is its lower sintering temperature and time compared to the conventional ceramic technique and direct formation of nano-ferrites without ball-milling *(S.S. Khot (Smt. Chandibai Himathmal Mansukhani College, Ulhasnagar); N.S. Shinde (D.B.J. College, Chiplun); B.B. Kale (P.D.Karkhanis College, Ambernath); **N.Basavaiah**; S.C. Watawe (S.I.C.E.S. Degree College of Arts, Science and Commerce, Ambernath);M.M. Vaidya (P.D.Karkhanis College, Ambernath)).*

Environmental magnetic studies on surface sediments: a proxy for metal and hydrocarbon contamination

Visakhapatnam is one of the major port cities, and it is developed into a hub of many large- and medium scale industries. Due to growing industrialization and urbanization, coast is vulnerable to both organic and inorganic micro-pollutants. Twenty-five surface sediments were collected along the Visakhapatnam coast for the measurement of texture size, petroleum hydrocarbons, trace metals and environmental magnetic parameters. The percentage of coarser particles was more in the northern region, whereas the percentage of fine particles was increased toward south. Elevated levels of petroleum hydrocarbons and trace metals were attributed due to marine and land-based sources, in particular, those were due to shipping activities, treated and partially treated sewage and industrial wastes. The concentrations of trace metals, petroleum hydrocarbons and magnetic minerals were decreased from nearshore to seaward. The results revealed that magnetic mineralogy is dominated by magnetite with a small proportion of hematite, and the grain size of magnetic minerals was in the range of pseudo-single domain to multidomain nature with detrital origin. From the principal component analysis, the magnetic concentration and mineralogy-dependent parameters co-vary with the heavy metal and PHC concentrations, suggesting that the inputs of magnetic minerals, petroleum hydrocarbons and heavy metals in the Visakhapatnam shelf sediments were derived from the same anthropogenic sources. Thus, the large magnetic dataset can be used to reduce the number of chemical analysis; hence, environmental magnetic parameters were used as a proxy for both organic and inorganic micro-pollutants **(Fig.18)** *(R. Venkatachalapathy,*

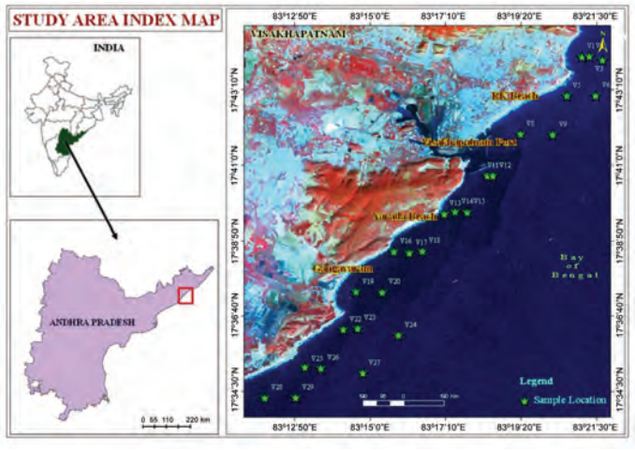


Figure 18

The sampling sites along the east coast of India, Visakhapatnam, Bay of Bengal.

V. Rajeswari (Annamalai University, Tamil Nadu); ***N. Basavaiah****;T. Balasubramanian (Annamalai University, Tamil Nadu)).*

Identification and characterization of tsunami deposits off southeast coast of India from the 2004 Indian Ocean tsunami: Rock magnetic and geochemical approach

December 2004 Indian Ocean Tsunami (IOT) had a major impact on the geomorphology and sedimentology of the east coast of India. Estimation of the magnitude of the tsunami from its deposits is a challenging topic to be developed in studies on tsunami hazard assessment. Two core sediments (C1 and C2) from Nagapattinam, southeast coast of India were subjected into textural, mineral, geochemical and rock-magnetic measurements. In both cores, three zones (noted zone I, II and II) have been distinguished based on mineralogical, geochemical and magnetic data. Zone II is featured by peculiar rock-magnetic, textural, mineralogical and geochemical signatures in both sediment cores that is interpreted to correspond to the 2004 IOT deposit. Textural, mineralogical, geochemical and rock-magnetic investigations showed that the tsunami deposit is featured by relative enrichment in sand, quartz, feldspar, carbonate, SiO_2, TiO_2, K_2O and CaO and by depletion in clay and iron oxides. These results point to a dilution of reworked ferromagnetic particles into huge volume of paramagnetic materials, similarly to what has been described in other nearshore tsunami deposit. Correlation analysis elucidated the relationships among the textural, mineral, geochemical and magnetic parameters, and suggests that most of the quartz-rich coarse sediments have been transported offshore by the tsunami wave. These results are well agreed with the previously published numerical model of tsunami induced sediment transport off southeast coast of India and can be used for future comparative studies on tsunami deposits *(S. Veerasingam, R. Venkatachalapathy (Department of Physics, Annamalai University, Annamalainagar, Tamil Nadu);* ***N. Basavaiah****; T. Ramkumar (Department of Earth Sciences, Annamalai University, Annamalainagar, Tamil Nadu); S. Venkatramana (Department of Earth Environmental Sciences, Pukyong National University, Busan, Republic of Korea);* ***K. Deenadayalan****).*

ELECTRICAL RESISTIVITY STUDIES

Analysis of electrical resistivity data in resolving the saline and fresh water aquifers in west coast Maharashtra, India

Electrical resistivity methods are widely used for identification of groundwater potential zones and in delineating the lateral and vertical distribution of sub-surface. This method can also characterize the ingress of sea water into inlands thereby getting mixed up with fresh water bodies. The present studies are an attempt to delineate the saline water-fresh water intrusion in parts of Kudal-Vengurla and surrounding coastal region of western Maharashtra. A total of 30 vertical electrical soundings were carried out in a near grid pattern using the Schlumberger configuration. The contour maps for Dar-Zarrouk parameters viz. the transverse resistance (T), longitudinal conductance (S), transverse resistivity (ρ_t) and longitudinal resistivity (ρ_l) were computed to generate the resistivity regime of saline and fresh water bearing formations. The results illustrate that the Dar-Zarrouk parameters provide a constructive solution in delineating the saline and fresh water aquifers, particularly when the resistivity data interpretation encounters constraints due to intermixing of saline water aquifers, fresh water aquifers etc. The pseudo cross-sections of resistivity data over five profiles in the study region show the flow of saline water from the coastal side, partly controlled by the lineaments **(Fig.19,20)** ***(G. Gupta;***

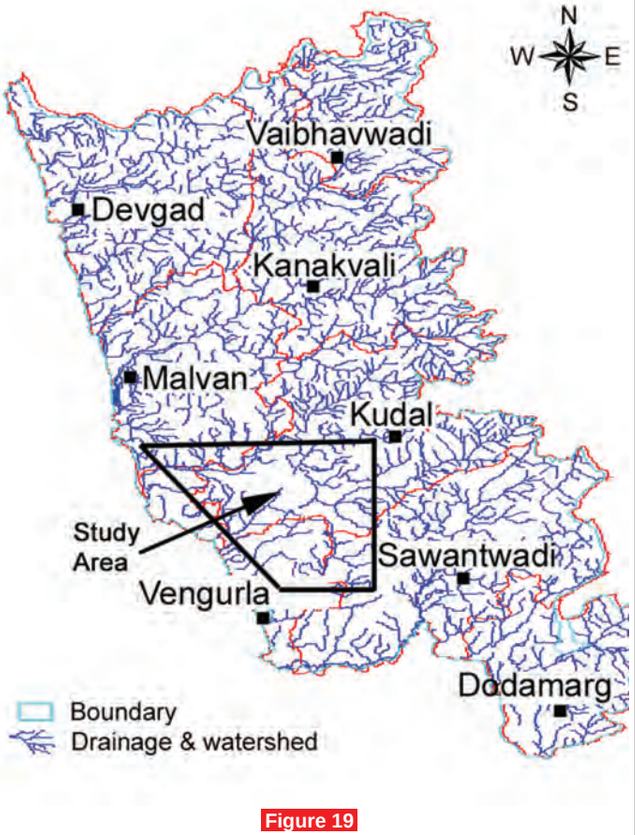


Figure 19

Geological and drainage map of Sindhudurg district showing the study area.

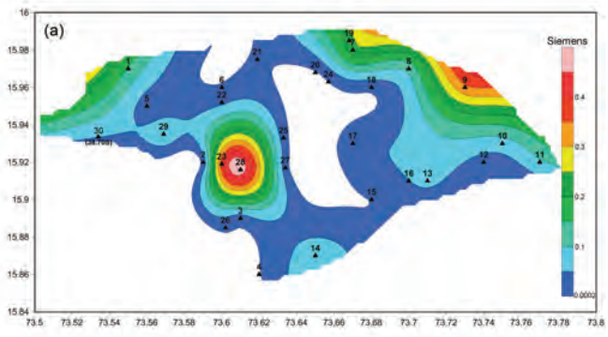


Figure 20a

Spatial distribution of longitudinal conductance (S) in the study area. VES point 30 is not considered in interpretation as the high S value (38.7 S) tends to mask the effects of other features in its vicinity. However, it is marked on the map and the S value is given in parenthesis.

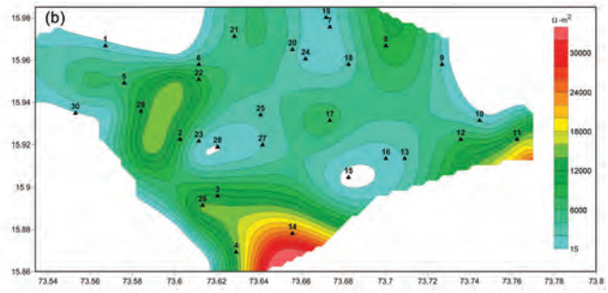


Figure 20b

Spatial distribution of transverse resistance (T) in the study area.

S. Maiti (Dept. of Applied Geophysics, ISM, Dhanbad); ***V.C. Erram****).*

PETROLOGIC AND PALAEOMAGNETIC RESEARCH

PALAEOMAGNETIC STUDIES

Magnetic properties of dolerite dykes and lamprophyre sills from Jharia coal fields, Damodar valley basin, India

The Gondwana (Early Permian to Early Cretaceous) basins of eastern India have been intruded by ultramafic-ultrapotassic and mafic (dolerite) dykes. Total 35 samples from 7 sites of dolerite dykes and lamprophyre sills have been collected from the Jharia coal field of the Damodar valley basin for rock magnetic studies. The investigations mainly comprise of magnetic susceptibility measurement, isothermal remanent magnetization (IRM), Lowrie-Fuller (L-F) test and thermomagnetic (K-T) experiment. The natural remanent magnetization (NRM) intensities measured on 450 specimens of dolerite dykes and lamprophyre sills show a mean value of 4.06 A/m and 0.003 A/m. Magnetic susceptibility values indicate mean values of 30.93 x 10^{-3} and 0.41 x 10^{-3} SI units. The Koenigsberger ratio (Q_n) value of dykes and sills show mean value of 3.47 and 0.19, respectively. Rock magnetic studies indicate that titano-magnetite/ magnetite of pseudo single domain (PSD)/ single domain (SD) type are the main magnetic minerals present in the studied samples of the Damodar valley basin *(**R.K. Nishad, Anup K. Sinha**; V. Kumaravel (GSI, Nagpur);* ***S.K. Patil****).*

Physical characterization, magnetic measurements, REE geochemistry and biomonitoring of dust load accumulated during a protracted inter fog period and their implications

The winter fog in India is a recurrent phenomenon for more than a decade now affecting the entire Himalayan and sub-Himalayan regions covering an area of nearly 500,000 km^2. Every winter (December–January), the air and surface transports in cities of northern India (Amritsar, New Delhi, Agra, Gwalior, Kanpur, Lucknow, and Allahabad) are severely disrupted with visibility reduced to <50 m at times. Since dust particles are known to act as nuclei for the fog formation, this study is aimed to carry out physicochemical characterization of the dust particulates accumulated during a protracted fog period from one of the severely fog affected cities of north India (Allahabad; 25°27′33.40″N-81°52′45.47″E). The dust-loaded tree leaves belonging to Ficus bengalensis and Ficus religiosa from 50 different locations between January 24 and 31, 2010 are sampled and characterized. The mass of dust, color, grain shape, size, phase constituents, and mineral magnetic parameters, such as magnetic susceptibility, SIRM, χfd%, and S-ratio, show minor variation and the regional influence outweighs local anthropogenic contributions. The dust compositions show fractionated rare earth element pattern with a pronounced negative Eu anomaly similar to upper continental crust and further suggesting their derivation from sources located in parts of north and central India *(M. Chakarvorty, J.K. Pati (Department of Earth and Planetary Sciences, University of Allahabad, Allahabad);* ***S.K. Patil****; S. Shukla, A. Niyogi (Department of Earth and Planetary Sciences, University of Allahabad, Allahabad); A.K. Saraf (Department of Earth Sciences, Indian Institute of Technology, Roorkee)).*

OBSERVATORY SYSTEM AND DATA ANALYSIS

OBSERVATORY DATA PROCESSING

One minute digital data from the **Digital Fluxgate Magnetometer** (DFM) system installed at magnetic observatories operated by the Institute namely, Tirunelveli, Pondicherry, Visakhapatnam, Alibag, Rajkot, Nagpur, Jaipur, Allahabad, Silchar, Shillong, Port Blair and Gulmarg covering latitudes ranging from equator to Sq focus are received at H.Q via e-mail in near real time. In addition to the DFM system, the analogue recording system, IZMIRAN, continues to be in operation at most of magnetic observatories listed above.

Absolute measurements recorded at all the stations are carried out by using high precision Declination Inclination Magnetometer (DIM) and Proton Precision Magnetometer (PPM) in addition to classical instruments. Definitive data of one minute resolution and hourly require these absolute measurements in order to compute respective baseline values. Computation of Definitive data of one minute resolution of the DFM system and hourly data of the analog system are done at H.Q., Navi Mumbai. Dedicated visual software and digital outputs of intercomparison of multi-station data of HDZ components are used as check points in maintaining the data quality.

Following thirteen papers are published by scientists, based on the geomagnetic data from IIG:

J. Geophys. Res., **118,**pp4352-4359, Jul 2013; *Adv.Space Res.,***52,** pp591-603, Aug 2013**;** *J.Atmos. Terr. Phys.,* **98,** pp63-73**,** Jun 2013;*Adv.Space Res***.,52,** pp158-176, July 2013;*J.Atmos. Terr. Phys.,* **104**, pp1-6, 2013; *Adv.Space Res.,* **51,**pp1924-1933, May 2013; *Ind. J. Rad. Sp. Phys.,* **42,** pp136-142, Jun 2013**;** *J.Atmos. Terr. Phys.,* **107,** pp 113**,** Jan 2014;*J. Geophys. Res.,* **118,** pp6736-6750**,** Oct 2013**;** *J.Atmos. Terr. Phys.,* **105-106,** pp 170-180, Dec 2013; *J.Atmos. Terr. Phys.,* **104,** pp 1-298, Nov 2013;*J.Atmos. Terr. Phys.,* **103**, pp 1-194, OCT 2013, *J.Atmos. Terr. Phys.,* **114,** pp 19-29, 2014

PUBLICATION OF MAGNETIC DATA

Hourly Absolute data of the Indian magnetic observatories for the year 2011 are computed using *the hourly mean values deduced from one minute magnetic field variations* of the three components of the earth's magnetic field. Mean hourly absolute values are published annually.

For the first time the 'INDIAN MAGNETIC DATA' are published on a DVD that contains data from **Ten** magnetic observatories. These DVD's are despatched to several universities and institutions in India and abroad. Hourly values of the magnetic fields at Institute's observatories have been deposited to World Data Centre, Mumbai. The magnetic storm sudden commencement amplitudes and ranges computed every month for magnetic observatories managed by IIG are deposited to World Data Centre, Colorado for inclusion in *Geophysical Data Bulletin***.**

Supplementary Volume of hourly values of Shillong and Gulmarg magnetic field data for 2006-2010 is published.

INTERMAGNET (*Inter*national *R*eal-time *Mag*netic Observatory *Net*work)

Near real time data received from INTERMAGNET System (at Alibag) are processed on daily basis and emailed to Kyoto GIN. Final one minute absolute values for the year 2012 are computed and sent to Paris GIN for inclusion in the annual DVD-ROM published by INTERMAGNET.

INTERMAGNET is the global network of observatories, monitoring the Earth's magnetic field. This programme exists to establish a global network of cooperating digital magnetic observatories, adopting modern standard specifications for measuring and recording equipment, in order to facilitate data exchanges and the production of geomagnetic products in close to real time. IIG is a participating Institute in this programme. Minute mean observations of the earth's magnetic field are relayed to the GINs within 72 hours of recording. In the current year **JAIPUR magnetic observatory** has complied with the standards set by the INTERMAGNET Executive Council and is now recognised as a full participating member of **INTERMAGNET** from **December 2013**. One minute definitive data of JAIPUR observatory for 2011/2012 submitted to Kyoto GIN. Near Real time data received from Jaipur observatory are processed provisionly on daily basis and emailed to Kyoto GIN.

SERVICE TO INDIAN NAVY AND OTHER ORGANISATIONS

(i) Prime magnetic observatory at Alibag serves as a calibration centre for magnetic instruments from organizations like SOI and NGRI. Calibration of Magnetic compasses received from Indian Navy, Indian Coast

Guard, Naval Air Stations, Indian Naval Ships and Pawan Hans Helicopter Ltd. are also undertaken. The Calibration work for a total of 37 magnetic compasses (Landing , Datum, Theodolite etc.) was carried out at Alibag Magnetic Observatory (Calibration charges per compass is Rs. 3000/-).

(ii) Calibration Certificates are prepared and issued to the respective naval departments to incorporate the correction factors as a measure to maintain higher degree precision in compass readings.

(iii) High resolution Digital magnetic data, hourly values and Magnetogram copies were supplied on requests to scientists and research students from Universities and research institutes in India and abroad for their investigational work.

(iv) Absolute Hourly values of Alibag 'H' component are sent on a monthly basis to WDC, Kyoto (Japan) for the compution of Dst Index.

(v) Using magnetic data of the 'H' component of Tirunelveli and low latitude station Alibag, equatorial electrojet strength is computed both in hourly and one minute resolution and are provided to scientists for use in their investigational work.

(vi) One minute definitive data of Alibag are supplied to national agencies for recent period which is used by them to supplement their geodetic, gravity and marine magnetic survey work.

Scientists downloaded the following digital data of **Alibag** from web: **IAGA Day files: 35672 days**

WORLD DATA CENTRE FOR GEOMAGNETISM (WDC, Mumbai)

WDC-Geomagnetism, Mumbai is now a member of the new global **ICSU WDS** system.

As per new ICSU WDS norms, modernization of the centre's infrastructure (renovation of WDC server cabin) and WDC database website are upgraded for additional online data services and Quick-look plots of real time data for 11 Indian stations.

- Around 90 new online data users registered with WDC website during this period.
- Digital imaging of Magnetograms is completed for 60 years for different stations as a process of long term preservation of magnetic records and also media migration activity of the centre.
- Data centre revamping work will be taken up to have standard data centre setup as per international standard of WDS.
- The ongoing conservation work of Colaba observatory magnetograms (1871-1904) is started from the magnetograms of 1871 onwards. Old Colaba magnetograms up to 1900 are treated for curative preservation process and the same procedure will be continued upto 1904 to complete all sets of magnetogram from Colaba Observatory.
- Indian station's magnetic data sets for year 2011 are checked and send to other WDC's as an international data exchange programs.

ANTARCTIC SCIENCES RESEARCH

On the UT and seasonal variations of the standard and SuperMAG auroral electrojet indices

The standard auroral electrojet (*AE*) indices are based on magnetic disturbance data from 10 to 12 northern auroral observatories. Recently, equivalent SuperMAG electrojet (*SME*) indices using data from around 100 mid latitude to high latitude observatories in the Northern Hemisphere. The *SME* indices were computed certainly have advantage over the *AE* indices in terms of number as well as temporal resolution of substorm onsets due to better latitudinal and longitudinal coverage. The UT and seasonal variations of geomagnetic activity have been extensively examined in the past. However, particularly for the *AE* indices, these variations have remained elusive due to sparse distribution of the *AE* observatories. In this study, Effect of the inclusion of large number of stations on the UT and seasonal variations of the auroral electrojets activities are examined. For this purpose, data for years 1997–2009 have been considered when consistently many stations (> 70) were available for the computation of the *SME* indices. It has been demonstrated that the *SME* indices exhibit grossly similar UT and seasonal variations as observed in the *AE* indices. However, there are subtle differences which arise due to difference in number of stations. The study suggests that most of the UT and seasonal variations of the *AE* indices, reported earlier, were mainly not due the sparse distribution of stations, but rather

to the actual physical processes that control them *(**Singh A. K., R. Rawat, B. M. Pathan**).*

First results from imaging riometer installed at Indian Antarctic station Maitri, Antarctica

Cosmic noise absorption (CNA) measurred by imaging Riometer, is an excellent tool to passively study the high latitude D-region ionospheric conditions and dynamics. An imaging Riometer has been installed at Indian Antarctic station Maitri (Geographic 70.75 degree S, 11.75 degree E; corrected geomagnetic 63.11 degree S, 53.59 degree E) in February 2010. This is the first paper using the imaging Riometer data from Maitri. Present paper introduces the detail of this facility, including its instrumentation, related CNA theory and its applications. Sidereal shift of around 2 hours in the diurnal pattern validates the data obtained from the newly installed instrument. Moreover, the strength of cosmic noise signal on quiet days also varies with months. This is apparently due to solar ionization of D-region ionosphere causing enhanced electron density where collision frequency is already high. The main objective of installing the imaging Riometer at Maitri is to study magneotspheric-ionospheric coupling during substorm processes. In the current study, Two typical examples of disturbed time CNA associated with storm-time and non-storm time substorm are presented. Results reveal that CNA is more pronounced during storm-time substorm as compared to non-storm time substorm. The level of CNA strongly depends upon the strengthening of convectional electric field and the duration of south-ward turning of interplanetary magnetic field before the substorm onset *(**J.K. Behera, Ashwini K. Sinha, Anand K. Singh, Rahul Rawat, G. Vichare, A. Dhar, B.M. Pathan, K. U. Nair, C. Selvaraj, P. Elango**).*

INSTRUMENTATION DIVISION

dIdD Vector Proton Magnetometer (dIdD VPPM)

The design of the existing Constant Current Source (CCS) of the Helmholtz coil based Vector Proton Magnetometer set up has been modified, which already existed at many of the magnetic observatories. The newly designed CCS has been integrated into microcontroller based Proton Magnetometer after thorough testing. Such a system has been installed at Alibag Magnetic Observatory and has been functioning well since then. Similar systems will replace the existing Helmholtz coil based VPPM setup in other observatories also.

Installation of Magnetometers

Digital Fluxgate Magnetometer (DFM) has been installed at Ooty, Gauribidanur as part of the south campaign of ODA group. Also two units of microcontroller based Proton Magnetometers have been fabricated, wired, tested and handed over to ODA group for campaign work. Six units of data-loggers have been fabricated for south campaign work.

Ovehauser PPMS has been installed at EGRL, Tirunelveli, magnetic observatories Nagpur and Jaipur.

Azimuth calibration has been done at Pondicherry magnetic observatory and EGRL, Tirunelveli using GPS.

Two units of microcontroller based 0.1 nT sensitivity PPM has been fabricated and handed over to Antarctica group which has been installed at Bharati and Maitri Antarctic stations of IIG.

NEW AND ONGOING PROJECTS

ANTARCTIC SCIENCES RESEARCH

Study of geomagnetic substorm

The new Indian Antarctic Station Bharati is fully operational now and the regular wintering has commenced. IIG members have been wintering here for the last two years providing uninterrupted magnetic, electric field and GPS data. Bharati Station (Geog. 69^{o}.41 S, 76^{o}.19 E, L=13.6) lies to the south of auroral zone (polar cusp region) and is an important region for studying substorms triggered at very high latitudes. Several very high latitude substorms were observed during the period of low solar activity for a long time. Various features of very high latitude substorms, e.g., local time dependence, interplanetary state, hemispherical asymmetry and their nightside low latitude signatures are being examined.

Ever since the introduction of the auroral electrojet (AE) indices (AU and AL) the scientific community has widely relied on them for substorm.

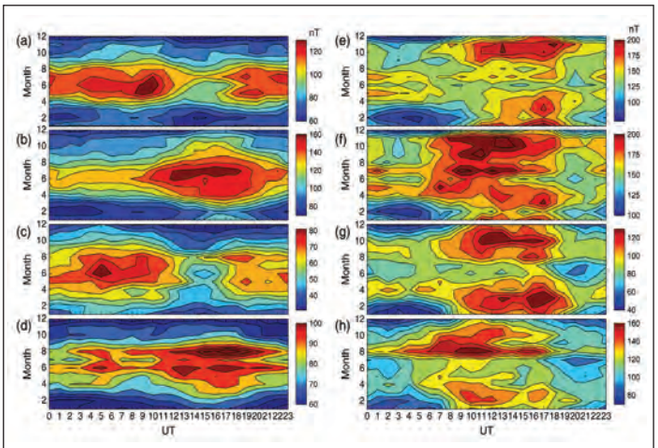


Figure 21

UT and seasonal variations of *AE and SME indices for maximum and minimum phases of* solar cycles. (a) UT and (b) seasonal variations of *AU and SMU indices, respectively, for solar maximum* years (2000–2005) and (c) UT and (d) seasonal variations of *AU and SMU indices, respectively, for* solar minimum years (1997–1999 and 2006–2009). (e, f) solar maximum years for *AL and SML indices,* respectively, and (g, h) same as Figures e and f but for solar minimum years.

However, these standard auroral indices are limited to certain extent in detecting substorms as their estimation is based on sparsely distributed stations in latitudes. SuperMag auroral indices based on large number of stations distributed in latitude can detect substorm onsets about 50% more in number and about 4 min earlier in time than those identified by the conventional Auroral indices.Using the large datasets of these indices over a number of years their dependence onUT, seasons and solar cycles are being studied **(Fig.21)**.

Cosmic noise absorption (CNA) measured by imaging riometeris an excellent tool to passively study the ionospheric dynamics. Sidereal shift of around 2 hours in the diurnal pattern of quiet day CNA validates the data obtained from the newly installed imaging riometer at Indian Antarctic station Maitri (geographic 70.75 S, 11.75 E; corrected geomagnetic 63.11 S, 53.59 E). Moreover, the strength of cosmic noise signal on quiet days displays a seasonal pattern apparently due to solar ionization of D-region ionosphere. Study revealed that the absorption is more pronounced during storm-time substorm as compared to nonstorm-time substorm. The level of CNA strongly depends upon the strengthening of convectional electric field and the duration of southward turning of interplanetary magnetic field before the substorm onset.The instrument is fully functional now (since December 2013) and is providing good quality data that could be used in corroboration with magnetic data for studying Magnetosphere-Ionosphere coupling **(Fig.22)**.

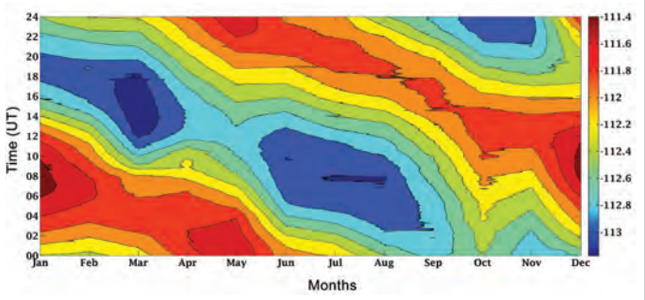


Figure 22

Contour plot for sidereal shift of maximum signal strength of cosmic noise signal for consecutive months. For the month January to May, shift of ~10 h (~10 to 00 UT) of maximum signal strength is seen. Similarly, for the month June to December, shift of ~14 h (~24 to 10 UT) is seen.

Global Electric Circuit (GEC) studies at Antarctica

Relationships connecting the climate of the planet earth and weather of the sun-earth system are studied under GEC (Global Electric Circuit) project. A number of electrical, magnetic, atmospheric pressure and meteorological sensors are deployed at high and low latitudes in order to understand different current systems. Possibilities of using Schumann resonance (i.e. ac component of GEC) as a proxy for planetary weather and climate trends are also being examined.

THEORETICAL INVESTIGATIONS OF SOLARWIND-MAGNETOSPHERE-IONOSPHERE COUPLING

Development and application of new fluid and kinetic simulation codes to study micro- and macro-scale wave phenomenon in plasma

One-dimensional fluid code has been developed on Intel FORTRAN platform. In this code, OpenMP (Open Multi-Processing) technique is used to reduce computational time of simulation job. Fourth order central finite difference scheme is used to solve spatial derivatives of the quantities and a Leapfrog method is used for time integration of fluid equations. The fluid code is general and can handle multi-species plasma. The localized perturbation in the plasma densities are required to initialized the code. The code is used to study and understand the evolution of initial density perturbation into different structures such as IA solitons, IA oscillations, and Langmuir waves.

Based on the Kyoto University Electro Magnetic Particle Code (KEMPO), one-dimensional electromagnetic Particle-

In-Cell (PIC) code is developed. In this code, Maxwell equations and equations of motion are solved by using finite difference time domain technique for large number of superparticles. The initial velocity distributions of electrons and ions are assumed to be drifted- Maxwellian distributions. The code is developed on the Intel FORTRAN platform and it uses Message Passing Interface (MPI) technique to reduce computational time.

Study of solarwind-magnetosphere-ionosphere system

The solar wind, magnetosphere and ionosphere form a single system driven by the transfer of energy and momentum from the solar wind to the magnetosphere and ionosphere. The plasma dynamics in this coupled system is quite complex in nature and depend on many parameters. It is necessary to understand how small-scale processes control large-scale phenomena, for example, magnetosphere - solar wind coupling, plasma entry through the magnetopause and cusp, magnetotail dynamics, magnetosphere-ionosphere coupling, field-aligned currents and substorm dynamics, etc. To understand these physical processes, broad range of analytical and computer simulation methods are used. A project has been undertaken to study the microscopic plasma processes in the magnetosphere and ionosphere using electrostatic particle simulation. The simulation code is being used to study the mulit-species plasma dynamics and the evolution of nonlinear electric field structures in the auroral acceleration region. The study is also being undertaken to understand the dynamics of low frequency waves in the solar wind and Earth's magnetosheath using linear theory and numerical simulations.

Theoretical investigations of solar wind-magnetosphere-ionosphere interactions have been conducted using several analytical and computational methods. Generation of ion- and electron-acoustic solitons is being carried out in different regions of the Earth's magnetosphere. Low-frequency waves are being studied using the loss-cone and other non-thermal distribution of energetic ions in the Earth's magnetosphere.

Theoretical Modeling of low latitude current system

An atmospheric tidal model based on classical tidal theory has been developed. The tidal structure due to conventional ozone and water vapor heating in conjunction with the O_2 absorption could be obtained without considering mean wind and dissipation mechanisms. The present tidal model reveals that the diurnal amplitude peaks in mid to low latitudes, whereas semidiurnal component is stronger at higher latitudes. The semidiurnal tide is about an order of magnitude weaker than the diurnal tide. Also, semidiurnal wave has longer vertical wavelength than diurnal tide.The results of present model are qualitatively in good agreement with the other tidal models, which utilize more sophisticated parameterization. Thus, the salient features of the tidal structure are obtained using basic computations without considering the effects of background winds and dissipation processes.

AIRGLOW STUDIES

Studies of the Night Time Ionospheric-Thermospheric Dynamics at Low Latitude by Ground-Based Spectroscopy

Nightglow emissions (OI 630 nm, OI 557.7 nm, OI 777.4 nm, NaD 589.3 nm, OH Band and O2 Atmospheric band) are being monitored from the ground with high resolution airglow equipments (All sky imager, All sky scanning photometer) to study the dynamics of the mesosphere-lower themosphere-ionosphere region. Monitoring of nightglow emissions (OI 630 nm, OI 557.7 nm, $P_1(2)$ and $P_1(4)$ lines of OH (6, 2) Meinel band, and OH Broadband emission) was carried out from Allahabad during October-November-December 2013 and January 2014. An investigation of gravity waves (having period ~ 1 – 3 h) observed in OH temperature measurements over Kolhapur during November 2002 and May 2003 was carried out. Signatures of Medium-scale Travelling Ionospheric Disturbances (MSTIDs) were noted in OI 630 nm imaging database over Ranchi on March 19, 2012. An investigation of possible connection between MSTIDs and the occurrence of Spread F was investigated in conjunction with imaging observations from Airglow Lab at Kolhapur and of National Atmospheric Research Laboratory at Gadanki. Measurements of spectroscopic OH rotational temperatures from the imaging observations of P_1 (2) line and P_1 (4) line of the OH (6, 2) Meinel band system were continued.

IONOSPHERIC IRREGULARITIES

Effect of disturbance dynamo (DD) electric field at low latitude F-region

Simultaneous observations of amplitude scintillations on 251MHz signal recorded by network of spaced receivers located at low latitude stations namely Tirunelveli, Kolhapur and Gadanki are utilized. The and its variability are studied in detail for magnetically disturbed days. Seasonal dependence of occurrence of Esb is studied using CADI ionosonde data during extremely low solar activity. Structuring and Evolution of spatial scales associated with ESF irregularities will be studied during different seasons, solar flux and geomagneticy conditions in forthcoming years.Earlier developed theoretical model will be used to understand the

observed distribution of coherence scale and to relate it to various characteristics of ESF irregularities.

ULF/ELF/VLF STUDIES

Geomagnetic Pulsations

Geomagnetic pulsations are the consequences of standing Alfven waves excited on geomagnetic field lines. A comprehensive analytic and numerical model of field line oscillations under different conjugate ionospheric conditions has been deloped. Half waves arise due to symmetric ionospheric conditions and are relevant to equinoxial periods, whereas quarter waves are relevant to solstices when conjugate ionospheres display strong asymmetry in conductivity. Characteristics of these waves are studied by analyzing magnetic data from satellite in corroboration with ground magnetic data at footprints. The observed frequencies are used in the developed model to compute the equatorial ion density and thus the model can be used as diagnostic tool for magnetospheric plasma **(Fig.23)**.

Very Low Frequency (VLF) Studies

VLF receivers at Allahabad, Nainital and Varanasi stations and Transient Luminous Events (TLE) monitoring experiment at Allahabad are maintained for operation to collect quality data. With the observations of low latitude whistlers from the VLF experiment further progress has been made in identifying the intricacies involved with whistlers propagation mechanism in low latitude ionosphere. Progress has been made on identifying the source region of whistlers, path of propagation and arrival azimuth determination of the whistler waves.

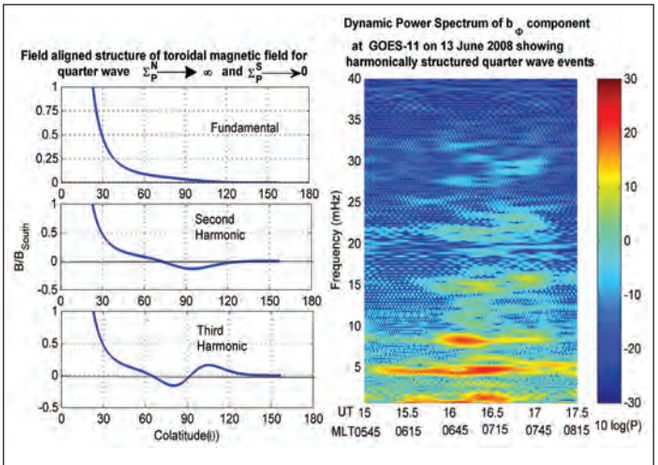


Figure 23

Theoretical computation of typical field aligned structure of quarter wave oscillations and observations of their harmonic structures from satellite GOES-11.

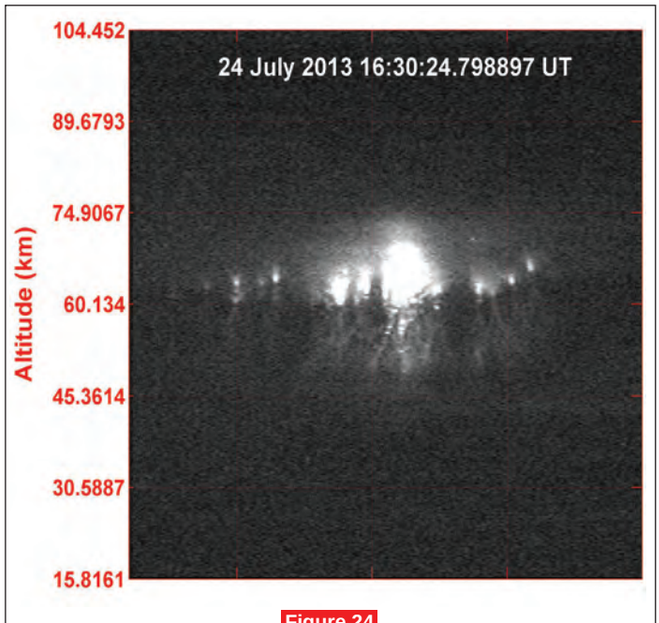


Figure 24

A sprite event observed at Allahabad by Transient Luminous Events (TLE) monitoring experiment.

Studies in the area of D-region ionosphere perturbations due to solar flares and variability in ionosphere due to solar eclipses is also being pursued. Earthquake precursor studies with VLF waves monitoring has been taken up to analyze the earthquakes which had happened in India and neighboring region **(Fig.24)**.

ATMOSPHERIC ELECTRODYNAMICS

The Balloon-borne Experiment on the Electrodynamics of Near Space (BEENS) Experiment

The Balloon-borne Experiment on the Electrodynamics of near Space (BEENS) was successfully conducted on a 110,000 cu. m balloon platform from the TIFR's National Balloon Facility at Hyderabad on 14th December 2013. The instrument package comprised of the 3-axis double probe electric field instrument, a 3-axis fluxgate magnetometer and a 3-axis search coil magnetometer. A float duration of about 4 hours at a ceiling altitude of 35 km could be achieved during this launch **(Fig.25)**. Though there were issues associated with the probe configuration and the boom assembly chosen for the vertical electric field measurements, two of the four horizontal electric field probes performed well and yielded useful data (see **Fig.26** for a sample of raw data from electric and magnetic field channels). The fluxgate magnetometer provided useful reference magnetic field data using which the north-south and east-west components of the electric

Figure 25

Balloon-borne Experiment on the Electrodynamics of near Space (BEENS) Experiment from the TIFR's National Balloon Facility at Hyderabad.

field are being derived for an Earth-fixed reference frame. The ac electric and magnetic field data were separately recorded in a dedicated data acquisition system at fast sampling rates. Analysis of dc and ac electric field data along with the VLF magnetic field data is in progress and the scientific results are expected soon.

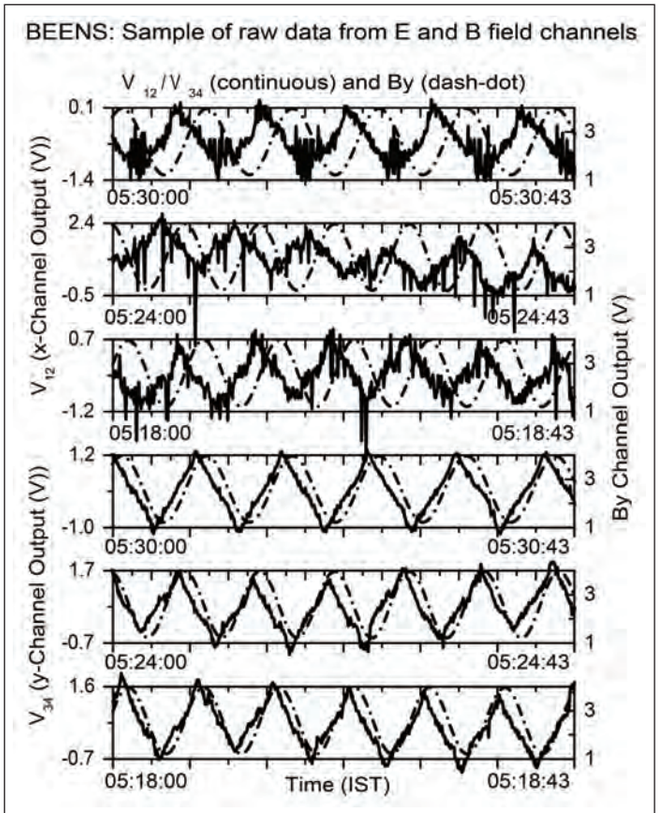


Figure 26

Sample of raw data (43 sec duration at every 6 min between 05:18 and 05:30 hrs IST) obtained from the electric and magnetic field channels from the balloon experiment conducted during pre-dawn hours on December 14, 2013, from the National Balloon Facility, Hyderabad.

ONGOING PROJECTS UNDER CAWSES INDIA PHASE II PROGRAMME

Variabilities of the ionosphere due to forcing from top and bottom

It is known that ionosphere responds differently to solar originated forces as well as wave forcing originated from the lower atmosphere. Under CAWSES India project, variabilities of the ionosphere due to forcing from top and bottom are being studied. It is known that solar originated forces such as geomagnetic storms and solar flares do affect the equatorial and low latitude ionosphere. In addition, present results also suggest that equatorial ionosphere do respond to forcing from lower atmospheric waves. Present study indicates that both forcing are to be taken into account in order to understand the equatorial ionosphere. It is suggested that the quiet-time variabilities seen in the GPS TEC over EIA could be caused due to the non-linear interaction of upward propagating planetary waves (PWs) with atmospheric tides. Presence of similar periods in the EEJ strength and TEC observations near the EIA crest region, supports the view that the large-scale wave like structures seen in TEC near the EIA crest are associated with atmospheric planetary scale waves. Attempts are being made to study these two using case studies over Indian region.

Role of wave-particle interactions in storm time ring current dynamics

During the main phase of the storms, the fractional concentration of the oxygen ions increases significantly and can influence the generation of low-frequency instabilities in the ring current. Oxygen and protons can be highly anisotropic. The objective of the project is to study the low-frequency waves excited by the anisotropic and kappa-type distributions of energetic oxygen ions and protons in the ring current region through wave-particle interaction and also estimate the decay time of the ring current during magnetic storms.

CRUSTAL AND DEEP CONTINENTAL RESEARCH

GEOPOTENTIAL STUDIES

Geopotential group of IIG is actively involved in research activities related to deciphering the Lithopsheric structure of the Indian Plate in general and in particular the Himalayas,

Western Continental Margin of India (WCMI) and the Aseismic Ridges in the Northern Indian Ocean. Currently focus is on a) integration of magnetic and gravity data, along with other geophysical techniques to understand the tectonic configuration and evolution of the WCMI including the Laxmi and Laccadive Ridge b) generation of the magnetic anomaly map of the Deccan trap covered region using ground magnetic data collected by IIG followed by its structural and tectonic interpretation c) identification of aeurole type magnetic anomalies related with the micro seepage of hydrocarbon in the Cambay basin and adjoining regions.

The study on "long wavelength gravity anomaly over Japan and adjoining regions: Implications on deep lithospheric structures" is presently being undertaken.

ELECTROMAGNETIC INDUCTION STUDIES

Lithospheric studies in Cambay basin using Magnetotelluric technique

The Magnetotelluric data (Broad-band and long-period) collected across north Cambay basin (Radhanpur-Patan) was analyzed for galvanic distortions using multi-site multi-frequency code of McNeice and Jones 2001. The distortion analysis for geo-electric strike is applied for single site with eight frequency bands and as a single frequency band. Once the approximate strike angle is estimated from the analysis, all sites with single band were incorporated for obtaining the geo-electric strike direction. The regional strike direction shows zero degrees across the study region and it coincides with geological strike of Cambay basin.As a result of this strike and distortion analysis, the obtained MT impedances were transformed in two different modes, TE and TM, in 2-D representing current systems parallel and perpendicular to the subsurface strike direction. The magnetotelluric data (TE, TM modes and vertical magnetic Hz tipper) from all five profiles were inverted using the two-dimensional (2-D) RLM2-DI algorithm of Rodi & Mackie, as implemented within the WinGLink package of Geosystem Srl. (now Schlumberger/ Western Geco). A homogeneous half-space, with a resistivity of 100 ohm-m was used as a starting model for all inversions. After many hundreds of iterations per profile and per run, best-fitting models were developed with normalized RMS value as 1.629. The geological interpretation is in progress for the above profile. The salient results are as follows:

- The 2D geo-electric section indicated thick (1-5 km) conductive sediments with resistivity 2-10 ohm in Cambay basin. The thickness of the basin is highest to the west of Patan.
- A mid to lower crustal conductor is delineated outside the basin and its presence is not clear within the basin.
- A high resistive body is shallowing towards west of the Cambay basin at deeper depths.
- A conductive body with resistivity 80 ohm-m is delineated at depth of 160-200 km and this layer may correspond to LAB boundary.

GLOBAL POSITIONING SYSTEM AND GEODESY STUDIES

Global Positioning System (GPS) is being used all over the world for numerous applications i.e. navigation on land, in air and on sea; determining precise coordinates of important geophysical features as an essential input to mapping etc. since GPS has also proved to be one of the most effective methods to measure the crustal movement.In India also an extensive high precision geodetic control network in campaign and continuous mode established by different organizations funded by Department of Science and Technology (DST) is in operation. As part of this research program, since 1995 onwards, GPS Geodesy Group in Indian Institute of Geomagnetism (IIG) has been carrying out the crustal deformation and glaciological studies in Indian and Antarctic regions.

The main research interest of the group focuses on the application of GPS geodesy to understand (a) plate kinematics and crustal deformation; (b) pre-, co- and post-seismic crustal deformation due to earthquake occurrences; (c) seismic hazard; (d) rheology of the Earth's mantle and (e) ice sheet dynamics of the Arctic and Antarctic regions. To augment and facilitate these studies, about 21 permanent GPS stations all over India and 2 permanent GPS stations at Antarctica have been established and initiative is being taken to establish more permanent stations. A number of semi-permanent/campaign stations have also been established in different parts of seismically active regions of India. Different field campaigns are being carried out in western Maharashtra, Kutch, Andaman-Nicobar Islands, Himalaya, northeast India and Polar regions.

ENVIRONMENTAL AND HYDROGEOPHYSICAL RESEARCH

ENVIRONMENTAL MAGNETISM STUDIES

The following projects are in progress in the Environmental Magnetism group,

1) Spectroscopic investigations of impact-shocked rocks and minerals at Lonar Crater.

2) Delineation of palaeoclimate record from analysis of the Lonar Lake sediment cores.

3) Revised magnetostratigraphy of the lava flow sequences of the Deccan Traps.

4) Palaeoclimatic analysis of the Himalayan proglacier lake sediments.

5) Archaeomagnetic dating of archaeological sites in Maharashtra and Andhra Pradesh.

ELECTRICAL RESISTIVITY STUDIES

Dykes from Deccan basaltic lava flows will be premeditated from the point of view of 1) their function in the hydrogeology of basaltic terrain 2) identifying their conduit and barrier type stretches and 3) to stumble on depth to which dykes clutch potential to amass and convey water.The study area is adjacent to Narmada-Tapi rift zone, in the Dhule and Nandurbar districts of Maharashtra, thus attaining regional significance wherein the dykes and dyke swarms occur as parallel to sub-parallel bodies intruding basaltic flows and forming linear ridges of moderate relief. For locating and identifying the presence of water bearing formations over dykes, applications of geophysical methods is widely recognized. It is proposed that in the coming years, two season (pre- and post monsoon) vertical electrical sounding (VES) studies will be carried out and complimented by ground magnetic method, to locate water table, thickness of sub-surface saturated formation (aquifers), carrier/barrier type stretches of dyke rocks and depth to the bedrock.

PETROLOGIC AND PALAEOMAGNETIC RESEARCH

PETROLOGICAL AND GEOCHRONOLOGICAL STUDIES

Petrology, geochemistry and geochronology of Precambrian mafic dyke swarms from the Singhbhum craton and its implication to paleocontinental reconstruction

A geological field survey was carried out for the collection of dyke samples in and around Chaibasa-Jhinkpani, Chaibasa-Tonto and Rajnagar-Gobindpur highways, for the petrological, geochemical and geochronological studies on the Precambrian mafic dyke swarms from Singhbhum Craton of Jamshedpur (Tata Nagar), Jharkhand area during December 2012. Total 59 samples were collected from 53 sites/locations of the igneous intrusive bodies from the south of the Singhbhum shear zones and 60 cylindrical cores were prepared in the laboratory. Newer Dolerites, which occur dominantly in NE-SW, NW-SE and N-S trend within Singhbhum granite. The prepared thin section contains calcic plagioclase and clinopyroxene in many samples. The common accessory mineral in the rocks is magnetite which is associated occasionally with ilmenite. The field studies reveal that these dolerites rocks have been affected by hydrothermal alteration.

Newer Dolerite dykes intruded in the Singhbhum craton which occur dominantly in NE-SW, NW-SE and N-S trend form a remarkable close and regular system of reticulatingdykes in the Singhbhum granite pluton. Petrographically, most of the thin section contains calcic plagioclase and clinopyroxene with a distinct ophitic texture. Replacement of clinopyroxenes by chlorite and actinolitic amphibole is noticed in many samples. Coarser, relatively less altered rocks reveal subsequent clinopyroxene (augite) partly enclosing plagioclase laths. The common accessory mineral in the rocks is magnetite which is associated occasionally with ilmenite. The field studies reveal that these dolerite rocks have been affected by hydrothermal alteration under lower green schist facies metamorphism. For authentic conclusion, geochemical and isotopic data for the petrogenesis of these newer dolerite dykes are to be analysed.

PALAEOMAGNETIC STUDIES

Low field AMS and rock magnetic investigations on dykes of Kumaun Lesser Himalaya

Low field anisotropy of magnetic susceptibility (AMS) and rock magnetic studies have been carried out on 11 dykes' samples belonging to Nainital, Almora and Pitoragarh regions of Kumaun Lesser Himalaya. Rock magnetic experiments comprising of temperature dependent susceptibilities (k-T curves) indicated that magnetite was the major magnetic mineral in the studied samples. Forward and back field Isothermal Remanent Magnetizations (IRMs) and Lowrie-Fuller tests exhibited the presence of multi domain (MD) magnetite in the Nainital and Pitoragarh dykes samples, whereas, Almora dykes indicated the single domain (SD) magnetic grains. Low field AMS data, generated from the 15 position magnetic susceptibility measurements, yielded well grouped maximum (K1), intermediate (K2) and minimum (K3) magnetic susceptibility directions. From the AMS data sets it was noticed that, E-W trending Phanerozoic dyke (~ 120 Ma) belonging to Almora area exhibited "Inverse fabrics", where foliation plane were defined by K2 and K3 axes, while

the Nainital and Pitoragarh dykes (Precambrian age ~ 550 Ma) showed "Normal fabric", where foliation plane were defined by K1 and K2 axes. From the observed AMS data sets it was inferred that NNW-SSE trending Pitoragarh dykes were fed by horizontal magma flows. However Almora dykes did not yield magma flow direction information as the single domain (SD) magnetite interactions yielded Inverse fabrics in the samples.

Mineral magnetic studies on Quaternary sediments of Tangtse valley, NW Himalaya, Ladakh

Mineral magnetic properties, such as magnetic susceptibility (χ_{lf}), anhysteritic remanent magnetizations (χ_{ARM}), isothermal remanent magnetizations (IRM) and their ratio parameters (S-ratio), were studied on 688 quaternary sediment samples collected from four sections exposed at Shachukul village of the Tangtse valley, NW Himalaya, Ladakh to understand the palaeo-climatic conditions in the region. Out of the studied four sections, two are lacustrine facies sections (ST-A) and ST-B), one flood facies section and the fourth one is basal sand section having thickness of 7.4, 17.5, 9.7, 5.0 meter respectively. For ST-A section majority of the pronounced peaks in magnetic susceptibility (χ_{lf}) positively correlate with the susceptibility of Anhysteretic Remanent Magnetization (χ_{ARM}), suggesting predominance of Single Domain (SD) magnetite that is characteristics of: (i) authigenic forms favouring restricted and calm bottom water conditions and/or (ii) those generated during poorly drained soil forming processes in lake catchments. SIRM indicates predominantly ferromagnetic composition. In ST-B section higher values of magnetic susceptibility (χ_{lf}) and ARM implies a close relationship between the erosion processes and increasing concentration of detritus input from the catchment probably during the comparatively warmer phases. Changes in χ_{lf} andχ_{ARM} of the ST-B section divides the 17.5 m section broadly into two climatic phases. From the base up to ~ 8 m it is warm phase and above represents the colder phase. The authigenic SD magnetite as evident from the peak indicate less oxygenated water condition for a short while due to the turbid water of flood event in Flood facies section. The Basal sand section shows weak susceptibility either due to low ferromagnetic content or negative susceptibility effect of diamagnetic carbonate matrix. (This is a collaborative project with BSIP, Lucknow, who are generating the other climate proxies such as radiocarbon dating, geochemistry, sedimentalogy, fossil and morphometric analyses on the samples).

COLLABORATIONS

DST sponsored India-Taiwan project

A new scientific project under India-Taiwan Science and Technology cooperation program has been initiated during this year jointly sponsored by DST (India) and NSC (Taiwan) for 3-year duration. The important objectives of this project include (i) Development of a suitable methodology for accurate retrieval of vertical electron density profiles from GPS-Radio Occultation (RO), (ii) Reprocessing of Formosat-3/COSMIC RO data with this new method for correcting the Abel retrieval errors (iii) Study of ionospheric undulations to severe geomagnetic and seismic activity using corrected RO data. As a part of fulfilment of this project, a modified Abel retrieval method using mean-value theorem of integration and weighted Abel transform is devised. The weights and asymmetry factors used in this method are computed from NeQuick model and the results show a significant improvement in the retrieved electron density profiles. Further, because of simplified solution using mean-value theorem, this modified Abel retrieval algorithm is much faster in processing time than the classical Abel retrieval procedure.

Linear and nonlinear studies of fluctuation phenomena in laboratory, space and astrophysical plasmas

The bilateral three years Indo-South Africa project is funded by the Department of Sceince and Technology, New Delhi, India and National Research Foundation, South Africa. The objective of the project is to investigate fluctuation phenomena observed in various plasma environments. The main focus is to explain either theoretically, computer simuluation or via numerical modeling, the experimental observations of wave phenomena in the Earth's magnetosphere and ionosphere, laboratory and astrophysical plasmas.

FIELD SURVEYS

1. Electrical resistivity imaging (ERI) studies were carried out in Chikotra river basin of Kolhapur district, Maharashtra during April, 2013 to decipher potential groundwater aquifer zones and to demarcate the faults in this region.
2. Carried out detailed resistivity imaging studies at prospective and saline water infected locations in Malwan-Oras-Kudal-Sawantwadi-Vengurla-Redi in Konkan region of Maharashtra to understand the two-dimensional extent and effects of saline water intrusion during November 2013.
3. On a request from the authorities of Vanvasi Kalyan Ashram, Resistivity imaging survey was conducted over three profiles in the campus of Vijaya Gopal Gandhi Ashramshala, Utekhol, Mangaon during March 25-26, 2014. The aim of the survey was to identify zone of potential groundwater for drilling a borehole for the inmates of the Ashramshala.
4. MT and LMT surveys were conducted in Ashara-Tharad-Disa-Dempti area of Camabay basin in North Gujarat during April-May 2013. The main objective of these studies was to (1) delineate the depth extension of Tertiary and Mesozoic sediments, (2) to identify high conductive layers in upper mantle depths due to Reunion plume activity and (3) determining the LAB depth across the profiles.
5. In order to understand the northward extension of Jasdan basin and lithosphere-asthenosphere boundary in the region, MT and LMT surveys were carried out in the northern part of Saurashtra region (Phase-III) during January-March 2014.
6. Long wavelength (5 km station spacing) ground magnetic and gradiometricsurveys were conducted over the Deccan trap covered regions of Maharashtra and adjoining states of Andhra Pradesh & Karnataka to understand the geologic and tectonic setting of the region. The survey was conducted in three phases spanning a total of 50 days during May, October and November 2013.
7. To understand the contemporary kinematics and related active deformation across the main Himalayan thrust zones due to India-Eurasia collision, the GPS geodesy group initiated and carried out 1st GPS campaign in Himachal and Garhwal Himalayan region from 01-04-2013 to 30-4-2013. A network of total 32 campaign mode GPS stations have been installed on exposed bed rocks and top of concrete pillars for a total coverage area of 250 x 250 sq. km.
8. To give an insight into the motion and related mass balance and future behavior of the Vestre Broggerbreen Glacier, Svalbard, Arctic, first GPS campaign has been carried out during the expedition from 1st August to 5th September 2013 with an installation of total 15 campaign sites on the glacier.
9. Rock samples of Dolerite dykes were collected for petrological studies from Gondawana Basin, Koderma in Jharkhand and Raniganj in West Bengal during December 2013.
10. Survey was carried out to collect oriented block samples from Salma dyke, Damodar Valley of Asansol and Koderma regions of West Bengal during December 2013.
11. Palaeomagnetic sampling of dyke formations intruded within the Deccan Trap basalts for revised magnetostratigraphy of volcanic sequencewere carried out along the west coast around Mumbai and Alibag during May 2013.
12. Lonar Lake was visited during June 2013 for collection of Lake-bed sediment during the pre-monsoon period from prefixed sites within Lake water.
13. Palaeomagnetic and rock magnetic sampling of the Himalayan terrain was carried out during August 2013. The areas surveyed were Leh-Ladakh, Nubra Valley and higher Himalayas.

PUBLICATIONS

PAPERS PUBLISHED DURING THE YEAR 2013-2014

Abraham, Noble P., Sijo Sebastian, G. Sreekala, R. Jayapal, **C. P. Anil Kumar** and Venugopal Chandu

Ion-acoustic instabilities in a multi-ion plasma, *J. Astrophys.*, http://dx.doi.org/10.1155/2013/838534, 2013.

Akala, A. O., **G. K.Seemala**, P. H. Doherty, C. E. Valladares, C. S. Carrano, J. Espinoza, and S. Oluyo

Comparison of equatorial GPS-TEC observations over an African station and an American station during the minimum and ascending phases of solar cycle 24, *Annales Geophysicae*, **31**, 2085–2096, doi:10.5194/angeo-31-2085-2013, 2013.

Anil Kumar, C. P.,R. Gopalsingh, C. Selvaraj, K. U. Nair, H. Johnson Jeyakumar, R. Vishnu, S. Muralidas and N. Balan

Atmospheric electric parameters and micrometeorological processes during the solar eclipse on 15 January 2010,*J. Geophys. Res.,***118**, 5098-5104, doi:10.1002/jgrd.50437, 2013.

Bagiya, Mala S., R. Sridharan, S. Sunda, L. Jose, T. K. Pant and R. Chaudhary

Critical assessment of the forecasting capability of L-band scintillations over the magnetic equatorial region – Campaign results, *J. Atmos. Sol. Terr. Phys*., **110-111**, 15-20, 2014.

Balan, N., P. K. Rajesh, **S. Sripathi**, **S. Tulasi Ram**, J. Y. Liu and J. Bailey

Modeling and observations of the north-south ionospheric asymmetry at low latitudes at long deep solar minimum, *Advances in Space Research*,**52**, 375-382,2013.

Bansal, A.R., **S.P. Anand**, **M. Rajaram**, V. K. Rao and V.P. Dimri

Depth to the bottom of magnetic sources (DBMS) from aeromagnetic data of central India using modified centroid method for fractal distribution of sources, *Tectonophysics*, **603**, http://dx.doi.org/10.1016/j.tecto.2013.05.024, 155-161, 2013.

Basavaiah, N., M.G. Wiesner, A. Anoop, P. Menzel, N.R. Nowaczyk, K. **Deenadayalan**, A. Brauer, B. Gaye, R. Naumann, N. Riedel and S. Prasad

Physicochemical analyses of surface sediments from the Lonar Lake, central India–implications for palaeoenvironmental reconstruction, *Fundam. Appl. Limnol.*, **184(1)**, 51-68, 2014.

Behera, J. K., Ashwini K. Sinha, Anand K. Singh, **Rahul Rawat, G. Vichare, A. Dhar,** B.M. Pathan, **K. U. Nair, C. Selvaraj** and **P. Elango**

First results from imaging riometer installed at Indian Antarctic station Maitri, Antarctica, *J. Earth Syst. Sci.,***03**, 593-602, 2014.

Bhaskar, A. and **G. Vichare**

Characteristics of penetration electric fields to the equatorial ionosphere during southward and northward IMF turnings, *J. Geophys. Res.*, **118**, 4696–4709, doi:10.1002/jgra.50436, 2013.

Bhattacharyya, A., B. Kakad, S. Sripathi, K. Jeeva and **K. U. Nair**

Development of intermediate scale structure near the peak of the F region within an equatorial plasma bubble, *J. Geophys. Res.,***119**, doi:10.1002/2013JA019619, 2014.

Bhardwaj, S. K. and **P. B. V. Subba Rao**

Secular trend of geomagnetic elements in the Indian region, *Earth Planets Space*, **65**, 1515 – 1523, 2013.

Chakrabarty,D., **Mala S. Bagiya**, S. V. Thampi, **B. M. Pathan** and R. Sekar

Signatures of moderate (M-class) and low (C, B class) intensity solar flares on the equatorial electrojet current: case studies, *J. Atmos. Sol. Terr. Phys.*,**105-106**, 170-180, 2013.

Chakrabarty, D.,B. G. Fejer, **S. Gurubaran**, Tarun K. Pant, M. A. Abdu and R. Sekar

On the pre-midnight ascent of F-layer in the June solstice during the deep solar minimum in 2008 over the Indian sector, *J. Atmos. Solar Terr. Phys.*, http://dx.doi.org/10.1016/j.jastp.2014.01.002, 2014.

Chakarvorty, M., J.K. Pati, **S.K. Patil**, S. Shukla, A. Niyogi and A.K. Saraf

Physical characterization, magnetic measurements, REE geochemistry and biomonitoring of dust load accumulated during a protracted inter fog period and their implications, *Environ. Monit. Assess.***, DOI: 10.1007/s10661-013-3594-4,** 2013**.**

Chatterjee, S., S. K. Chakraborty, **B. Veenadhari**, **S. Banola**

A study on ionospheric scintillation near the EIA crest in relation to equatorial electrodynamics, *J. Geophys.Res.* **DOI: 10.1002/2013JA019466**, 2013.

Costa, Jr. E., B, T. Tsurutani, M. V. Alves, E. Echer and **G. S. Lakhina**

Cross-field diffusion of energetic (100 keV to 2 MeV) protons in interplanetary space,*Astrophys. J.*, **778:180** (5pp), doi:10.1088/0004- 637X/778/2/180, 2013.

Devendraa Siingh, P. S. Buchunde, R. P. Singh, Asha Nath, Sarvan Kumar and **R. N. Ghodpage**

Lightning and rainfall study in different parts of India**,***Atmos. Res.Jour.*,**137**, 35-48, dx.doi.org/10.1016/j.atmosres.2013.09.018 , 2014.

Dewangan, P., **N. Basavaiah**, F.K. Badesab, A. Usapkar, A. Mazumdar, R. Joshi and T. Ramprasad

Diagenesis of magnetic minerals in a gas hydrate/cold seep environment off the Krishna–Godavari basin, Bay of Bengal, *Mar. Geol.,***340(1)**, 57-70, 2013.

Galav, P., Shweta Sharma, S.S. Rao, **B. Veenadhari**, T. Nagatsuma and R. Pandey

Study of simultaneous presence of DD and PP electric fields during the geomagnetic storm of November 7–8, 2004 and resultant TEC variation over the Indian Region, *Astrophys. Space Sci.,* **350 (2),** DOI 10.1007/s10509-014-1792-3, 459-469, 2014.

Gokarn, S.G., C.K. Rao, C. Selvaraj, G. Gupta and B.P. Singh

Crustal evolution and tectonics of the Archean Bundelkhand Craton, Central India, *J. Geol. Soc. India*, **82**, 455-460, 2013.

Kakad, A., Y. Omura and **B. Kakad**

Experimental evidence of ion acoustic soliton chain formation and validation of nonlinear fluid theory, *Phys. Plasma*, **20**, 062103, 2013.

Khot, S.S., N.S. Shinde, B.B. Kale, **N. Basavaiah**, S.C. Watawe and M.M. Vaidya

Microstructure and infrared absorption spectroscopic study of Zn substituted Li-Cu ferrites, *Int. J. Chem. Phys. Sci.,***3**, 107–116, 2014.

Lakshmi Narayanan,V., S. Gurubaran, K. Emperumal and **P. T. Patil**

A study on the night time equatorward movement of ionization anomaly using thermospheric airglow imaging technique, *J. Atmos. Solar Terr. Phys.*, **103**, 113-120, 2013.

Maharaj, S. K., R. Bharuthram, **S. V. Singh**, and **G. S. Lakhina**

Existence domains of dust-acoustic solitons and supersolitons, *Phys. Plasmas*, **20,** doi: 10.1063/1.4818439, 2013.

Mishra, D.C. and **M. Ravi Kumar**

Proterozoic orogenic belts and rifting of Indian cratons: Geophysical constraints, *Geoscience Frontiers*,**5**, 25-41, 2014.

Nair, N., **S.P. Anand** and **M. Rajaram**

Tectonic framework of Laccadive Ridge in Western Continental Margin of India, *Marine Geology*, **346**, dx.doi.org/10.1016/j.margeo.2013.08.009, 79-90,2013.

Nade,D. P., A. K. Sharma, S. S. Nikte, **P. T. Patil, R. N. Ghodpage,** M. V. Rokade, **S. Gurubaran**, A. Taori and Y. Sahai

Zonal velocity of the equatorial plasma bubbles over Kolhapur, India, *Ann. Geophys.*, **31**, 2077-2084, 2013.

Nikte, S. S.,A. K. Sharma, D. P. Nade, G. A. Chavan, M. V. Rokade, **R. N. Ghodpage, P. T. Patil** and R. V. Bhonsle

Study of Diurnal, Seasonal and Annual Variations in the Cosmic Radio Noise Absorption at 30 MHz in the Australian Antarctic Research Stations**,***Canadian J. Basic Appl. Sci.*, **1-3**, 145-154, 2013.

Nishad, R.K., Anup K. Sinha, V. Kumaravel and **S. K. Patil**

Magnetic properties of dolerite dykes and lamprophyre sills from Jharia coal fields, Damodar Valley Basin, India, *J. Ind. Geophys. Union*, **18(4)**, 341-348, 2013.

Parihar, N. and **G. K. Mukherjee**

A case study of gravity waves observed in OH rotational temperatures at Kolhapur (16.8º N, 74.1º E), India, *Ind. J. Radio Space Phys.*, **43**, 67-74, 2014.

Pradhan, R., S. K. Prajapati, S. Chopra, A. Kumar, B. K. Bansal and **C. D. Reddy**

Causative source of Mw 6.9 Sikkim-Nepal border earthquake of September 2011: GPS baseline observations and strain analysis, *J. Asian Earth Sci.*, **70-71**, 179-192, doi.org/10.1016/j.jseaes.2013.03.012, 2013.

Prasad, S., A. Anoop, N. Riedel, S. Sarkar, P. Menzel, **N. Basavaiah**, R. Krishnan, D. Fuller, B. Plessen, B. Gaye, U. Röhl, H. Wilkes, D. Sachse, R. Sawant, M.G. Wiesner and M. Stebich

Prolonged monsoon droughts and links to Indo-Pacific warm pool: A Holocene record from Lonar Lake, central India, *EPSL,* **391**,171-182, 2014.

Prasad Rao, A S K A V., P. S. Brahmanandam, G. Uma, A. Narendra Babu, C. Y. Huang, G. Anil Kumar, **S. Tulasi Ram**, H. L. Wang, Y. H. Chu

Planetary-scale wave structures of Earth's Atmosphere using COSMIC observations,*Acta Meteorologica Sinica*, **10.1007/s13351-014-0101-y**, 2013.

Prizomwala, S.P., N. Bhatt and **N. Basavaiah**

Provenance discrimination and source-to-sink studies from a dryland fluvial regime: An example from Kachchh, western India, *Int. J. Sediment Research,* **29,** 99-109, 2014.

Rajaram, M. and **S.P.Anand**

Aeromagnetic signatures of Precambrian shield and suture zones of Peninsular India,*Geoscience Frontiers*, **5**, dx.doi.org/10.1016/j.gsf.2013.06.005**,** 3-15, 2014.

Rajaram, M., **S.P. Anand** and Kumar H. Singh

Proxy heat flux and magnetization model from satellite magnetic data,*J. Geophysics*, **34**, 55-61, 2013.

Rao, N.V.C., **Anup K. Sinha**, S.Kumar and R.K. Srivastava;

K-rich titanate from the Jharia ultrapotassic rock, Gondwana coal fields, Eastern India and its petrological significance, *J. Geol. Soc. India*, **81**, 733-737, 2013.

Ravi Kumar, M., D.C.Mishra and B.Singh

Lithosphere, crust and basement ridges across Ganga and Indus basins and seismicity along the Himalayan front, India and Western Fold Belt, Pakistan, *J. Asian Earth Sci.*,**75**,126-140, 2013.

Remya, B., R. V. Reddy, B. T. Tsurutani, **G. S. Lakhina** and E. Echer

Ion temperature anisotropy instabilities in planetary magnetosheaths, *J. Geophys. Res*., **118, doi:10.1002/jgra.50091**, 2013.

Rufai, O. R., R. Bharuthram, **S. V. Singh** and **G. S. Lakhina**

Effect of hot ion temperature on obliquely propagating ion-acoustic solitons and double layers in an auroral plasma, *Commun. Nonlinear Sci. Numer. Simulat.*, **19(5)**, 1338–1346, 2014.

Sandeep, V., **P.K. Das**, H. Muthurajan, S. Radha and **N. Basavaiah**

Magnetic and dielectric measurements of Mn substituted $LaFeo_3$ compounds, *Int. J. Chem.Phys. Sci.,***3**, 83–90, 2014.

Sarkar, S., H. Wilkes, S. Prasad, A. Brauer, N. Riedel, M. Stebich, **N. Basavaiah** and D. Sachse

Spatial heterogeneity in lipid biomarker distributions in the catchment and sediments of a crater lake in central India, *Organic Geochemistry*, **66**, 125-136, 2014.

Sarma, K.P., M. Venkateshwarlu, **S.K. Patil**, J.J. Laskar, NivaRani Devi and J. Mallikharjuna Rao

Palaeomagnetic study of Metadolerite dykes and sills from Proterozoic Shillong Basin, NE India: Implications related to the age and magmatism,*J.Geol.Soc. Ind.*, **43**, 147-155, 2014.

Seemala, G.K., M. Yamamoto, A. Saito and C.H. Chen

Three-dimensional GPS ionospheric tomography over Japan using constrained least squares, *J. Geophys. Res.,* **119**, 3044-3052, doi:10.1002/2013JA019582, 2014.

Sharma, A. K., D. P. Nade, S. S. Nikte, **P. T. Patil, R. N. Ghodpage**, R. S. Vhatkar, M. V. Rokade and **S. Gurubaran**,

Occurrence of equatorial plasma bubbles over Kolhapur**,** *Adv. Space Res.*, **54(3)**, 435-442, doi.org/10.1016/j.asr.2013.07.018), 2014.

Shinde, N.S., S.S. Khot, R.M. More, B.B. Kale, **N. Basavaiah**, S.C. Watawe and M.M. Vaidya

Cation distribution of Cu^{2+} substituted NiZn ferrite, *Int. J. Chem. Phys.Sci.,***3**, 27–36, 2014.

Shrivastava, M.N., C. D. Reddy and S. K. Prajapati

Topographic constraints on deviatoric stress field in the Indo-Eurasian collision region: seismo-tectonic implications, *PAGEOPH*, **170(4)**, 515-527, doi: 10.1007/s00024-012-0570-9, 2013.

Shrivastava, M.N. and **C. D. Reddy**

The $\mathbf{M_w}$8.6 Indian Ocean earthquake on 11 April 2012: Coseismic displacement, Coulomb stress change and aftershocks pattern, *J. Geol. Soc. India*, **81(6)**, 813-8210, 2013.

Singh, Anand K., R. Rawat and **B.M. Pathan**

On the UT and seasonal variations of the standard and SuperMAG auroral electrojet indices, *J. Geophys. Res.*, **118**, 5059-5067, doi:10.1002/jgra.50488, 2013.

Singh,As. K.,A.K. Singh, **R. Singh** and R.P. Singh

Solar Flare induced D-region ionospheric perturbations evaluated from VLF measurements, *Astrophys. Space Sci.*, DOI 10.1007/s10509-013-1699-4, 2013.

Singh, S. V., S. Devanandhan, G. S. Lakhina and R. Bharuthram

Effect of ion temperature on ion-acoustic solitary waves in a magnetized plasma in presence of superthermal electrons, *Phys. Plasmas,* **20**, 012306; doi: 10.1063/1.4776710, 2013.

Srivastava,P.R.,**Sneha A. Gokani, Ajeet K. Maurya, R. Singh**, Sushil Kumar, **B. Veenadhari, R. Selvakumaran**, A.K. Singh, D. Siingh and J. Lichtenberger

One-to-one relationship between low latitude whistlers and conjugate source lightning discharges and their propagation characteristics, *Adv. Space Res.,***doi.org/10.1016/j.asr.2012.07.005**, 2013.

Srivastava, R.K., S. Kumar, **Anup K Sinha** and N. V Chalapathi Rao

Petrology and geochemistry of high-titanium and low-titanium mafic dykes from the Damodar valley, Chhotanagpur Gneissic Terrain, eastern India and their relation to mantle plume(s), *J. Asian Earth Sciences*, **84**,35-50, 2014.

Sripathi, S., N. Balachandran, **B. Veenadhari**, **R. Singh** and **K. Emperumal**

Response of the equatorial and low latitude ionosphere to an intense X-class solar flare (X7/2B) as observed on 09 August 2011**,** *J.Geophys. Res.,***118(5)**, 2648-2659, doi: 10.1002/jgra.50267, 2013.

Subbiah M. and **M. S. Anil Iype**

On the Stability of a Compressible Axial Flow with an Axial Magnetic Field, *Jour.Fluids,*http://dx.doi org/10.1155/2013/869324, 2013.

Tiwari, V.M., **M. Ravi Kumar** and D.C. Mishra, Long wavelength gravity anomalies over India: Crustal and lithospheric structures and its flexure, *J. Asian Earth Sci.*,**70–71**, 169-178, 2013.

Tomchou Singh, Ksh., G.N. Nayak, L.L. Fernandes, D.V. Borole and **N .Basavaiah**

Changing environmental conditions in recent past- Reading through the study of geochemical characteristics, magnetic parameters and sedimentation rate of mudflats, central west coast of India, *Palaeogeogr., Palaeoclimatol., Palaeoecol.,***397**, 61-74, 2014.

Tsurutani, B. T., B. J. Falkowski, J. S. Pickett, O. P. Verkhoglyadova, O. Santolik, and **G. S. Lakhina**

Extremely intense ELF magnetosonic waves: A survey of polar observations, *J. Geophys. Res.***119**,doi:10.1002/2013JA019284, 2014.

Tsurutani, B. T. and **G. S. Lakhina**

An extreme coronal mass ejection and consequences for the magnetosphere and Earth, *Geophys. Res. Lett.,***41**, doi:10.1002/2013GL058825, 2014.

Tsurutani, B. T., **G. S. Lakhina** and O. P. Verkhoglyadova

Energetic electron (>10keV) microburst precipitation, ~5–15 s x-ray pulsations, chorus and wave-particle interactions: a review, *J. Geophys. Res.*, **118**,doi:10.1002/jgra.50264, 2013.

Tsurutani, B. T., A. J. Mannuccci, O. P. Verkhoglyadova and **G. S. Lakhina**

Comment on “Storming the Bastille: the effect of electric fields on the ionospheric F-layer” by Rishbeth et al. (2010), *Ann. Geophys.,***31**, 145–150,doi:10.5194/angeo-31- 145- 2013, 2013.

Tulasi Ram,**S.,** M. Yamamoto, R. T. Tsunoda, H. D. Chau, T. L. Hoang, B. Damtie, M. Wassaie, C. Y. Yatini, T. Manik and T. Tsugawa

Characteristics of Large Scale Wave Structure (LSWS) observed from African and southeast Asian longitudinal sectors, *J.Geophys. Res.,***119**, doi:10/1002/2013JA019712, 2014.

Venkatachalapathy, R., V. Rajeswari, **N. Basavaiah** and T. Balasubramanian

Environmental magnetic studies on surface sediments: a proxy for metal and hydrocarbon contamination, *Int. J. Environ.Sci. Technol.,***doi: 10.1007/s13762-013-0355-4**, 2013.

Verkhoglyadova, O. P., B. T. Tsurutani and **G. S. Lakhina**

Theoretical analysis of Poynting flux and polarization for ELF-VLF electromagnetic waves in the Earth’s magnetosphere, *J. Geophys. Res.*,**118**,doi:10.1002/2013JA019371, 2013.

Venugopal, C., S. George, V.R. Rajeev, R. Jayapal, M.J. Kurian and **C.P. Anil Kumar**

Study of magnetosonic waves in an anti-loss cone plasma, *Indian J. Phys.*, **87(9)**, 939-945, doi:10.1007/s12648-013-0315-3, 2013.

Vichare, G. and R. Rajaram

Diurnal and Semidiurnal tidal structures due to O_2, O_3 and H_2O heating, *J.Earth Syst. Sci.*, **122(5)**, 1207-1217, 2013.

PAPERS IN PROCEEDINGS/TECHNICAL REPORTS

Gopinath, G., T.R. Reshmi, A.S. Hameed, M. Parveenbabu, **P.S. Sunil** and **Rahul Rawat**

Ionic composiion of a high altitude lake– the Schirmacher Oasis, East Antarctica, In: *Proc.International Symposium on Integrated Water Resources Management*, **1**, 717-722, ISBN:978-81-8424-906-4, Allied Publishers, 2014.

Gopinath, G., T.R. Reshmi, A.S. Hameed, M. Parveenbabu, **P.S. Sunil** and **Rahul Rawat**

Chemistry of a polar lake– the Larsemann Hills in Antarctica, In: *Proc.International Symposium on Integrated Water Resources Management,* **1**, 745-751, ISBN:978-81-8424-906-4, Allied Publishers, 2014.

Prajapati, S.K., **P. S. Sunil** and **C. D. Reddy**

Plate boundary deformation following the December 26, 2004 Andaman-Sumatra earthquake revealed by GPS Observations and Seismic Moment Tensors,*Earth on the Edge: Science for a Sustainable Planet,In: Proc. International Association of Geodesy Symposia,***138**, 175-182, doi: 10.1007/978-3-642-37222-3_22, Springer-Verlag Berlin Heidelberg, 2014.

Sinha, Anup K. and R.K. Srivastava

Geochemistry of distinct mafic dykes from the Damodar valley Gondwana basins and Chhotanagpur Gneissic Terrain, Eastern India: implications for their petrogenesis and tectonic setting, *Geol. Soc. America, GSA abstract,* **45(7)**, 2013.

PAPERS ACCEPTED DURING THE YEAR 2013-2014

Bhattacharyya, A., B. Kakad, K. U Nair and **K. U. Jeeva**

Development of intermediate scale structure near the peak of the F region within an equatorial plasma bubble, *J. Geophys. Res.,* 2014.

Ghodpage, **R. N.,** A. Taori, **P. T. Patil, S. Gurubaran, S. Sripathi, S. Banola** and A.K. Sharma

Simultaneous optical measurements of Equatorial Plasma Bubble (EPB) from Kolhapur (16.8° N, 74.2° E) and Gadanki (13.5° N, 79.2° E), *J. Atmos. Solar-Terrestrial Phys.*, 10.1016/j.jastp.2014.05.008, 2014.

Gupta, G., S. Maiti and **V.C. Erram**

Analysis of electrical resistivity data in resolving the saline and fresh water aquifers in west coast Maharashtra, India, *J. Geol. Soc. India*, 2013.

Sharma,A. K., D. P. Nade, S. S. Nikte, P. T. Patil, **R. N. Ghodpage**, R. S. Vhatkar, M. V. Rokade and S. Gurubaran

Occurrence of Plasma Bubbles Over Kolhapur,*Adv. Space Res.*, dx.doi.org/10.1016/j.asr.2013.07.018, 2013.

Sharma,A.K., S. S. Nikte, M. V. Rokade, D. P. Nade, **R. N. Ghodpage**, **P. T. Patil** and R. V. Bhonsle

Observed difficulties for study of cosmic radio noise using Riometer at low latitude station, Kolhapur,*Adv. Space Res.,* dx.doi.org/10.1016/j.asr.2013.10.030, 2013.

Veerasingam, S., R. Venkatachalapathy, **N.Basavaiah**, T. Ramkumar, S. Venkatramanan and **K. Deenadayalan**

Identification and characterization of tsunami deposits off southeast coast of India from the 2004 Indian Ocean tsunami: Rock magnetic and geochemical approach, *J. Earth Syst. Sci.*, 2014.

IMPACT FACTOR OF PUBLICATIONS DURING 2013-2014

Journal Name	Impact Factor
Acta Meteorologica Sinica	0.8
Adv. Space Res.	1.18
Ann. Geophysicae	1.518
Astrophys. J.	6.73
Astrophys. Space Sci.	2.06
Atmos. Res. Jour.	2.2
Canadian J. Basic Appl. Sci.	0.2
Commun. Nonlinear Sci. Numer. Simulat.	2.773
Earth Planets Space	2.92
Environ. Monit. Assess.	2.09
EPSL	4.35
Fundam. Appl. Limnol.	1.19
Geophys. Res. Lett.	3.98
Indian J. Phys.	1.79
Int. J. Chem. Phys. Sci.	1.02

Journal Name	Impact Factor
Int. J. Environ.Sci. Technol.	1.84
Int. J. Sediment Research	0.72
J. Asian Earth Sci.	2.38
J. Atmos. Solar-Terr. Phys.	1.42
J. Earth System Sci.	0.7
J. Geol. Soc. India	0.57
J. Geophys. Res.	3.17
J. Ind. Geophys. Union	0.225
Mar. Geol.	2.73
Organic Geochemistry	2.52
Pure App. Geophys.	1.62
Palaeogeogr., Palaeoclimatol., Palaeoecol.	2.75
Physics of Plasmas	2.376
Tectonophysics	2.68

INVITED TALKS AND LECTURES

Anand, S.P.

Proxy heat flow map of the Indian sub-continent from magnetic data ***(Invited)***, Pandit Deendayal Petroleum University, Gandhinagar on July 26, 2013.

*Use of Advanced Geomagnetic Tools in Hydrocarbon Exploration,****(Invited)***, CoD Basement Exploration Group, ONGC, Priyadarshini, Mumbai, November 28, 2013.

Bagiya, M.

GPS Navigation system, delivered to visiting final year students under educational visit programme from DY Patil Polytechnic College, Nerul, Navi Mumbai, January 17, 2014.

Space weather - recent advances,delivered to visiting final year M.Sc. students under educational visit programme from Institute of Sciences, Mumbai, February 12, 2014.

Basavaiah, N.

Geomagnetism: Looking at the 'devastating events' in the Earth's history ***(Invited)***, Gurunanak College Mumbai in connection with the "National conference on research trends in smart materials–igniting minds" during January 3-4, 2014.

Bhattacharyya, A.

Variability of near-Earth geospace: implications for future Earth ***(Invited),*** 50th Annual Convention of the Indian Geophysical Union, Hyderabad, January 8-12, 2014.

Geospace environment under weak solar influence: Some issues ***(Invited),*** Atmospheric Sciences Brainstorming Workshop, SRM University, Chennai, April 27, 2013.

Spatial structure and dynamics of intermediate-scale irregularities in the post-sunset low latitude Ionosphere ***(Invited),*** Fall Meeting of the American Geophysical Union, San Francisco, USA, December 9-13, 2013.

Bhattacharyya, A., B. Kakad *and* ***S. Sripathi***

*Is the Equatorial Plasma Bubble more structured at the top than near the equatorial F layer peak? (****Invited****),*12th Scientific Assembly of the International Association of Geomagnetism and Aeronomy (IAGA), Merida, Mexico,August 26- 31, 2013.

Bhattacharyya, A. *and K. C. Okpala*

Day-to-day variability of the quiet-time equatorial and low latitude geomagnetic field ***(Invited),*** 12th Scientific Assembly of the International Association of Geomagnetism and Aeronomy (IAGA), Merida, Mexico,August 26- 31, 2013.

Dhar, A.

IIG's scientific activities, delivered to visiting students from Madhya Paradesh selected for Vigyan Manthan Yatra 2013-14 under M.P. Mission Exellence Programme, January 14, 2014.

Basics of Geomagnetism, delivered to visiting students from Madhya Paradesh selected for Vigyan Manthan Yatra 2013-14 under M.P. Mission Exellence Programme, January 14, 2014.

Introduction to Geomagnetism, delivered to visitng 2nd year students under educational visit programme from Don Bosco Institute of Technology, Mumbai, February 14, 2014.

Basics of Geomagnetism and studies conducted at Antarctica, delivered to visiting 2nd year science students from Wilson College, Mumbai, February 18, 2014.

Erram, V.C.

Studies in Geomagnetism- Scope and applications ***(Invited)***, Department of Geology, Gopal Krishna Gokhale College, Kolhapur during August 16-17, 2013.

Geopotential method ***(Invited)***, School of Environmental & Earth Sciences, North Maharashtra University, Jalgaon during October 15-18, 2013.

Geochronology, Age of the Earth, magnetic method of prospecting and thermal history of the Earth, (Guest lectures on these topics) delivered to the 1st year M.Sc. (Applied Geology& Geography) students.at School of Environmental & Earth Sciences, North Maharashtra University, Jalgaon, March 5-7, 2014.

Ghosh, S. S.,

Fully nonlinear analysis of electrostatic solitary waves and double layers in the presence of double layers ***(Invited),***28th National Symposium on Plasma Science and Technology (PLASMA 2013), KIIT, Bhubaneshwar,December 3-6, 2013.

Ghosh, S.S., S. Gurubaran, R.V. Reddy, S.V. Singh, A.K. Sinha, S. Sripathi, S. Tulasiram, B. Veenadhari, G. Vichare, et al.

Review of L1 Mission Payload Proposals: IIG's perspective, ISRO HQ., Bangalore, June 19-20, 2013.

Gupta, G.

Invited lectures on (1) *General Geophysics*, (2) *Electrical Resistivity Method*, to the M.Sc. students at Department of Geology, Gopal Krishna Gokhale College, Shivaji University, Kolhapur during August 16-17, 2013.

Invited lectures at School of Environmental and Earth Sciences, North Maharashtra University, Jalgaon, during October 15-18, 2013 on (i) *Magnetotelluric technique and its applications* (ii) *Electrical resistivity technique for groundwater prospecting.*

Invited to School of Environmental & Earth Sciences, North Maharashtra University, Jalgaon during March 5-7, 2014 as a Visiting Faculty to impart lectures on the topics, *Physics & Chemistry of the Earth, Seismology and earth processes, and Geophysical techniques* to the 1st year M.Sc. (Applied Geology and Geography) students.

Gurubaran, S. *and* ***S. Sathishkumar***

Tidal and planetary wave coupling of the equatorial mesosphere-lower thermosphere-ionosphere region ***(Invited)***,XII Scientific Assembly of IAGA, Merida, Mexico,August 26-31, 2013.

Kakad, A. P.

Electrostatic solitary waves in space plasmas ***(Invited),***11th international School/Symposium for Space Simulations,National Central University, Taiwan, July 21-28, 2013.

Coherent electric field structures in geospace plasmas, RISH, Kyoto University, Japan, August 26, 2013.

Lal, M.

Climatology of Infrasound, Dept. of Physics, Motilal Nehru National Institute of Technology, Allahabad, June 11, 2013.

Change and meteorological variability over Indian region during severe earthquake, Department of Earth and Planetary Sciences, Allahabad University, January 24, 2014.

Patil, S.K.

Invited to give a lecture on *Palaeomagnetic investigations on the flows and dykes of Deccan Volcanic Province: constraints on the age and span of the Deccan eruptions* at the Society of Earth Scientists Foundation Day Lecture in the Department of Earth and Planetary Sciences, Allahabad University, Allahabad on April 27, 2013.

Reddy, C.D.

Invited to address 23 delegates from 14 countries of the International Course on "Geospatial Technology Application in Location Based Services and Navigation", held at National Institute of Rural Development (NIRD), Hyderabad, during February 10-March 23, 2014. Delivered five talks pertaining to GPS technology, Errors in GPS, GPS application in Earth Sciences, GPS applications in Atmospheric sensing and Space Weather.

Rajaram, M. *and* ***S.P. Anand***

Invited by Society of Petroleum Geophysicist (SPG) for conducting one day course work for the 4th consecutive year. The title of the course work was *Advances and Efficiency of Potential field methods in Hydrocarbon exploration*, held on November 22, 2013 at Hotel Le Meridian, Kochi.

Singh, S. V.

Electron-acoustic solitary waves in presence of non-thermal electrons and a warm electron beam ***(Invited)***, Workshop on Fluctuation Phenomena in Space Environment, Hermanus, South Africa, May 30-31, 2013.

Electromagnetic ion cyclotron (EMIC) waves are in the inner magnetosphere, Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, Sagamihara, Kanagawa, Japan, January 8, 2014.

Electromagnetic ion cyclotron (EMIC) waves are in the inner magnetosphere: Waves and plasma properties, STEL, Nagoya University, Nagoya, Japan, January 24, 2014.

Singh, R.

Very Low Latitude VLF-Whistler Phenomena, RISH, Kyoto University, Kyoto, Japan, November 14, 2013.

Sinha, Ashwini K.

A comprehensive studies on geomagnetic pulsations ***(Invited)***, National symposium on nonlinear and complex phenomena held at Jadavpur during 7-9 January, 2014.

Fundamentals of Geomagnetism, delivered to visitng final year M.Sc. students under educational visit programme from Institute of Sciences, Mumbai, February 12, 2014.

Sripathi, S.

Multi-parametric observations of ESF irregularities over Indian region over the last 4 decades: A brief review, National Central University, Taiwan, September 24, 2013.

Tulasiram, S.

Studies on zonal LSWS and scintillation over Indian equatorial and low-latitude region using Radio Beacon Receiver Network ***(Invited)***, Atmospheric Sciences Brainstorming Workshop, SRM University, Chennai, April 26-27, 2013.

On the detection of initial seed perturbation for the Equatorial Plasma Bubbles (EPBs) and its characteristics observed from Indian equatorial station, Tirunelveli (***Invited)***, 18th National Space Science Symposium , Dibrugarh, January 29-February 01, 2014.

Altitudinal response of thermosphere-ionosphere system for short period recurrent geomagnetic activity during deep solar minimum, National Central University, Taiwan, July 17, 2013.

On seeding of Equatorial Plasma Bubbles - role of Large Scale Wave Structure (LSWS) and its characteristics, National Central University, Taiwan, October 2, 2013.

Equatorial Plasma Bubbles – role of Large Scale Wave Structure, Kyushu University, Japan, March 13, 2014.

Veenadhari, B., *T. Kikuchi, Y. Ebihara,* ***Sandeep Kumar*** *and* ***S. Tulasiram***

Penetration of long duration of convection/overshielding electric fields to equatorial latitudes during magnetic storm periods and their effects on F region ionosphere ***(Invited),*** 12th Scientific Assembly of the International Association of Geomagnetism and Aeronomy (IAGA), Merida, Mexico, August 26-31, 2013.

Veenadhari, B.

Study of Geomagnetic field Variations at low latitudes using ground and Satellite Observations, WDC, Kyoto, Kyoto University, Japan, March 2, 2014.

Vichare, G.

Study of Equatorial Electrojet and Sq current systems using satellite and ground magnetic field measurements, Data Analysis Center for Geomagnetism and Space Magnetism (DACGSM), Kyoto University, March 3, 2014.

PARTICIPATIONS IN CONFERENCES/MEETINGS/SEMINARS

NATIONAL

National Workshop on CAWSES India Programme (NAWCIP-2013), April 30 – May 2, 2013, National Atmospheric Research Laboratory (NARL), Gadanki

Parihar,N.

An investigation of the mesospheric gravity wave activity using all-sky imaging technique.

Sripathi, S., **B. Kakad**, A. K. Patra, T. K. Pant and **A. Bhattacharyya**,

A study of Equatorial Spread F (ESF) irregularities using theoretical and experimental techniques in the ascending phase of solar cycle-24.

Singh, R., Abhay K. Singh, A.K. Singh and D. Siingh

Coordinated study of VLF waves in India.

National Symposium on nonlinear dynamics, June 5–8, 2013, MNNIT, Allahabad

Lal,M.

Atmospheric waves in the middle atmosphere.

35th Annual Convention, Seminar and Exhibition of Association of Exploration Geophysicist (AEG), October 3-5, 2013, New Delhi

Anand, S.P., N. Nair and **M. Rajaram**

Structure and evolution of the Laccadive Ridge from the analysis of Free Air Gravity anomalies.

Erram, V.C., G. Gupta, J.B. Pawar and Suyash Kumar

Geophysical techniques for identifying aquifer zones within dykes of northern Maharashtra.

Gupta, G., V.C. Erram and **S.H. Mahajan**

Saline water incursion in fresh water aquifers of Konkan coast, Maharashtra: a geophysical perspective.

28th National Symposium on Plasma Science and Technology (PLASMA 2013), December 3-6, 2013, KIIT, Bhubaneshwar

Devanandhan, S., S. V. Singh, G. S. Lakhina and R. Bharuthram

Nonthermal effects on the obliquely propagating electron-acoustic solitary waves.

Kakad, A.P., B. Kakad and Yoshiharu Omura

Breaking of ion acoustic solitary waves in warm plasma.

Gokani Sneha A. and **R. Singh**

Arrival Azimuth Determination of Multi-Station Recorded Low Latitude Whistlers.

Maurya, Ajeet K., R. Singh and **B. Veenadhari**

Night time D-region plasma density measurements from lightning generated tweek radio atmospherics recorded at low latitude India station.

Venkatesham,K., Ajeet K. Maurya, R. Selvakumaran, B. Veenadhari and **R. Singh**

Perturbations in the low latitude D-region Ionosphere due to Solar Flares.

National Level Seminar on Explore Physics (ODNLSEP-2013), December 29, 2013, Department of Physics, Changu Kana Thakur, ACS College, New Panvel, Mumbai

Nikte,S. S., A. K. Sharma, D. P. Nade, G. A. Chavan, **R. N. Ghodpage**, P. T. Patil, M. V. Rokade and R. V. Bhonsle

Study cosmic radio noise absorption recorded by Riometers during solar proton event.

Sharma,A. K., D. P. Nade, A. Taori, S. S. Nikte, **P. T. Patil**, G. A. Chavan, **R. N. Ghodpage** and **S. Gurubaran**

Effect of Milky Way on OI 630 nm nightglow intensity.

National conference on research trends in smart materials–igniting minds, January 3-4, 2014, Gurunanak College, Mumbai

Sandeep, V., **P.K. Das**, H. Muthurajan, S. Radha and **N. Basavaiah**

Magnetic and dielectric measurements of Mn substituted $LaFeo_3$ compounds.

Shinde, N.S., S.S. Khot, R.M. More, B.B. Kale, **N. Basavaiah**, S.C. Watawe and M.M. Vaidya

Cation distribution of Cu^{2+} substituted NiZn ferrite.

National symposium on nonlinear and complex phenomena, January 7-9, 2014, Jadavpur University, Kolkata

Sinha, Ashwini K.

A comprehensive studies on geomagnetic pulsations.

50th IGU Annual Convention and Meeting on Sustainability of Earth System- the Future Challenges, January 8-12, 2014, CSIR- National Geophysical Research Institute, Hyderabad

Sinha, Ashwini K., J.K. Behera, Anand K. Singh and **Rahul Rawat**

Consequence of interplanetary conditions on the auroral substorm absorption (ASA) events over sub-auroral latitude.

Bhardwaj, S.K., P.B.V. Subba Rao and **B. Veenadhari**

Geomagnetic jerks in Indian region.

Vichare, G., Rahul Rawat, A. Bhaskar and **B.M. Pathan**

Effect of sudden impulse in the Solar wind dynamic pressure on the geomagnetic field.

Ponraj, M., and **S. Amirtharaj**

Inferring crustal deformation in the Kumaun Himalaya using GPS observations.

Ravi Kumar, M., D.C. Mishra and B. Singh

Lithosphere, crust and basement ridges across Ganga and Indus basins including seismicity based on gravity-magnetic studies.

Reddy, C.D., S.K. Prajapati and B.R. Arora

Imaging the source of September 18, 2011 earthquake in Sikkim Himalaya.

Subba Rao, P.B.V., A.K. Singh and **C.K. Rao**

Geomagnetic depth sounding in Andaman region, NE Indian Ocean.

Veenadhari, B. and **M.S. Anil Iype**

Characteristics of long term variation of EEJ and associated return currents over Indian sector.

Vijay Kumar, K.

Continuous GPS monitoring at Allahabad: 5 year time-series results.

DST Young Scientist Meet, January 28-29, 2014, S. N. Bose Institute, Kolkatta

Bagiya, Mala S.

Space Weather – recent advances.

National conference on Environment: Pollution and Protection (EPP-2014), January 30- February 1, 2014, National Institute of Technology, Durgapur

Gupta, G., V.C. Erram, S. Maiti and **S.H. Mahajan**

Assessment of saline water incursion using geophysical and geochemical data from west coast Maharashtra, India.

18th National Space Science Symposium 2014, January 29 – February 1, 2014, Dibrugarh University, Dibrugarh, Assam

Bhaskar, A. and **G. Vichare**

Artificial neural network modelling of geomagnetic field variations for Indian region.

Banola, S. and **S.Sripathi**

Occurrence characteristics of ionospheric scintillation over Mumbai and its correlation to PRE using CADI ionosonde at Tirunelveli.

Bhardwaj,S. K., B. Veenadhari and **P. B. V. Subba Rao**

Day-to-day variability of Sq current system in the Indian region.

Chavan,G. A., A. B. Gavade, A. K. Sharma, S. S. Nikte, D. P. Nade, C. M. Swami, **R. N. Ghodpage** and **P. T. Patil**

Study of Pre and post midnight observations of VHF amplitude scintillation at low latitude station Kolhapur (16.42°N, 74.2°E, and 10.6°N dip lat.).

Devanandhan, S., S. V. Singh and **G. S. Lakhina**

Obliquely propagating electron-acoustic solitary waves in the presence of superthermal hot electrons and an electron beam.

Ghodpage, R. N., A. Taori, P. T. Patil, S. Gurubaran, D. Siingh, S. Nikte, D. Nade , G. A. Chavan and A. K. Sharma.

Characteristics of mesospheric gravity wave derived from the OH airglow emissions at Kolhapur (India).

Sandeep Kumar, B. Veenadhari, S. Mukherjee, S. Tulasiram and **B. D. Kadam**

Superposed epoch analysis of geomagnetic stormevents of Solar cycle 23 and their interplanetary characteristics.

Bagiya, Mala S., R. Sridharan, Surendra Sunda, Tarun K. Pant, Rajkumar Choudhary and L. Jose

Critical assessment of the forecasting capability of L-band scintillation over the magnetic equatorial region – Campaign results.

Gokani, Sneha A. and **R. Singh**

On the examination of source region of low latitude whistlers: Correlation study with lightning activity at conjugate point.

Lal, M.

Depletion in the Ionospheric F-layer in Response to cloud-to-ground lightening.

Lal, M.

Outgoing long wave radiation variability from NOAA NCEP CPC GLOBAL monthly data prior to Major Earthquake.

Lal, M.

Surface latent heat flux from ECMWF Reanalysis data as an earthquake precursor.

Maurya, Ajeet K., D. V. Phanikumar, **R. Singh**, Sushil Kumar and **B. Veenadhari**

First observations of wave like signatures in D-region Ionosphere associated with 22 July 2009 Total Solar Eclipse: Co-ordinated measurements using VLF waves from India, Korea and Fiji.

Nade,D. P., A. K. Sharma, S. S. Nikte, **P. T. Patil, R. N. Ghodpage**, M. V. Rokade, S. Gurubaran, A. Taori and Y. Sahai

Zonal Velocity of the Equatorial Plasma Bubbles over Kolhapur, India.

Thomas, N., G. Vichare, Ashwini K. Sinha and **B. Jayashree**

Role of ionosphere in modulating Pi2 pulsations.

Sathishkumar,S., P. Priyanka, S. Sridharan and **S. Gurubaran**

Climatology of solar and lunar tides in the mesosphere and lower thermosphere over Tirunelveli (8.7^{o}N, 77.8^{o}E).

Sharma, A. K, D. P. Nade, S. S. Nikte, G. A. Chavan, P. T. Patil,**R. N. Ghodpag** and **S. Gurubaran**

Zonal Velocities of EPBs by Recent Developed Techniques.

Sridharan,R., **Mala S. Bagiya**, Surendra Sunda, Rajkumar Choudhary, Tarun K. Pant and Lijo Jose

Forecasting the spatial occurrence pattern of L-band scintillations and its temporal evolution – first results from Indian longitudes.

Sripathi,S., B. Kakad, Sreeba Sreekumar, S. Banola, R. N. Mourya and A. K.Patra

Linking spaced receiver VHF scintillation observations with radar observations.

Sripathi, S., N. Balachandran, **B. Veenadhari, R. Singh** and **K. Emperumal**

Response of the equatorial and low-latitude ionosphere to an intense X-class solar flare (X7/2B) as observed on 09 August 2011.

Venkatesham, K., Ajeet K. Maurya, R. Selvakumaran, B. Veenadhari and **R. Singh**

Study of the Solar flare induced D-region ionospheric perturbations.

Raman Memorial Conference (RMC) 2014, February 7-8, 2014, Dept. of Physics, Pune University, Pune

Patil, P.T., R. N. Ghodpage, S. Gurubaran, D. Nade, S. Nikte, A. K. Sharma and D. Siingh

Study of Equatorial Plasma Bubble (EPB) using OI 630.0 nm emission over low latitude station.

Workshop on Advanced Dynamical Core Modeling For Atmospheric and Oceanic Circulations (ADCMAOC-2013), February 18-23, 2013, NARL, Gadanki

Sharma, A., S. S. Nikte, **J. K. Behera**, **Ashwini K. Sinha**, D. P. Nade, **R. N. Ghodpage**, M. V. Rokade, **P. T. Patil,** R. V. Bhonsle and **B. M. Pathan**

Study of Longitudinal and Latitudinal variations in the signal strength pattern of cosmic radio noise using riometers at southern and northern hemispheres.

National Conference on Innovation in IT and Managements (NCIITM-2014), February 21-22, 2014, Sinhgad Institute of Management and Computer Application, Narhe Technical Campus, Pune

Patil, R.P., S. B. Patil, **R. Ghodpage, P. T. Patil** and D. P. Nade

Star Detection and Removal in Night Airglow Images.

INTERNATIONAL

International workshop on Changing Chemistry in Changing Climate: Monsoon (C4), May 1-3, 2013, IITM, Pune

Lal, M.

Climatology of atmospheric variability over Indian region.

Japan Geoscience Union (JpGU) International Symposium, May 19-24, 2013, Japan

Kakad A. P., Y. Omura and **B. Kakad**

Nonlinear evolution of electrostatic solitary waves in the Earth's boundary layers: two-fluid warm plasma simulations.

Workshop on Fluctuation Phenomena in Space Environment, May 30-31, 2013, Hermanus, South Africa

Lakhina, G.S., S.V. Singh and **A.P. Kakad**

Generation of Alfven waves by velocity shear of the ion beams flowing along auroral field lines.

Maharaj, S.K., R. Bharuthram, **S.V. Singh** and **G.S. Lakhina**

Existence regions of arbitrary amplitude ion-acoustic and electron-acoustic solitons in two-electron temperature space plasmas.

Rufai, O. R.,R. Bharuthram, **S. V. Singh** and **G. S. Lakhina**

Ion-acoustic solitons and double layers in a magnetized plasma with two temperature electrons.

Bharuthram, R.,O. R. Rufai, **S. V. Singh** and **G. S. Lakhina**

Ion-acoustic solitary waves and double layers in a magnetized plasma with double Maxwellian electrons and adiabatic ions.

10th Annual Meeting, Asia Oceania Geosciences Society, June 24-28, 2013, Brisbane, Australia

Thomas, N., G. Vichare, Ashwini K. Sinha and **B. Jayashree**

Effect of the Ionosphere on the Propagation of the ULF Waves.

Sinha, Ashwini K., A. K. Singh, **J. K. Behera, Rahul Rawat, B. Jayashree** and **B. M. Pathan**

Spatial Characteristics of Substorm Associated Dayside Pi2 Pulsations at Low Latitudes.

Sinha, Ashwini K.

Geomagnetic Pulsations: Theory and Observations.

Jayashree, B., Ashwini K. Sinha and **G. Vichare**

Theoretical and Observational Aspects of Quarter Wave Toroidal Oscillations in the Earth's Magnetosphere.

Manu, S., K. Jeeva , C. Paneerselvam, P. Elango, Rahul Rawat, Ashwini K. Sinha and **S. Gurubaran**

Simultaneous Observation of DC and AC Components of Global Electric Circuit Parameters Over Maitri, Antarctica.

Sunil, P.S., C. Kreemer, **C. D. Reddy**, G. Blewitt, S. K. Prajapati, **M. Ponraj** and **S. Amirtharaj**

Contemporary kinematics of northeast Indian plate boundaries revealed by earthquake and GPS data.

Tulasi Ram, S., N. Balan, **B. Veenadhari, Sandeep Kumar** and S.-Y. Su

Altitudinal variation of equatorial zonal electric field using ground based magnetometers and in-situ observtions.

Balan, N.,**S. Tulasi Ram**, P. K. Rajesh and J. Y. Liu

Statistics of Geomagnetic Storms in 50 years.

Selvakumaran, R., B.Veenadhari, Sandeep Kumar and N. Gopalswamy

Coronal Mass Ejection-driven IP shocks and associated magnetic storms of solar cycle 23.

Sandeep Kumar, S. Tulasi Ram and **B. Veenadhari**

Possible relationship between the daytime vertical ExB vertical drift velocities in F region using ground magnetic and satellite observations over Indian sector.

58th Annual Conference of the South African Institute of Physics, July 9-13, 2013, University of Pretoria

Maharaj, S.K., R Bharuthram, **S.V. Singh** and **G.S. Lakhina**

Arbitrary amplitude nonlinear wave structures in two-electron temperature space plasmas.

11th International School/Symposium for Space Simulations (ISSS-11), 21-28 July 2013, Taiwan

Devanandhan, S., S.V. Singh, G.S. Lakhina and R. Bbharuthram

Oblique propagation of electron acoustic solitons in magnetized plasmas with superthermal electrons.

Kakad, B., **A.P. Kakad** and Yoshiharu Omura

On the applicability of Fluid and Particle-In-Cell approach in explaining electrostatic solitary structures in space plasma.

International conference on "Water, Wastewater & Isotope Hydrology (ic-wwish-2013), July 25-27, 2013, Jnanabharathi, Bangalore University, Bangalore, India

Erram, V.C. and **G. Gupta**

Demarcating potential aquifer zones using seasonal variation and geophysical indicators in northern Deccan Volcanic Province of Maharashtra.

Gupta, G., V.C. Erram and **S.H. Mahajan**

Saline water intrusion in coastal aquifers- a case study from western Maharashtra.

International Association of Geomagnetism and Aeronomy, August 26-31, 2013, Mexico

Bhattacharyya A., Kakad B. and **Sripathi S.**

Is the equatorial plasma bubble more structured at the top than near the equatorial F-layer?

Nair, N., S.P. Anand and **M. Rajaram**

Crustal structure of Laxmi Ridge in the Arabian Sea.

Nayak, C.K., A. Bhattacharyya, B. Kakad, S. Sripathi and **K. Emperumal**

F3-layer formation due to the downward movement of plasma

Rajaram, M. and **S.P.Anand**

Aeromagnetic evidence of plate tectonics in the Precambrian.

Gurubaran, S. and **S. Sathishkumar**

Tidal and planetary wave coupling of the equatorial mesosphere-lower thermosphere-ionosphere region.

Veenadhari, B., S. Mukherjee and **S.Gurubaran**

Advances and developments in Geomagnetic observatories maintained by Indian institute of Geomagnetism, India.

Veenadhari, B., S. Mukherjee, B. D. Kadam and **S. Gurubaran**

Extreme Space weather events as seen in the historical geomagnetic records at Colaba Observatory, India.

Veenadhari, B., T. Kikuchi, Y. Ebihara, **Sandeep Kumar** and **S. Tulasi Ram**

Penetration of long duration of convection/overshielding electric fields to equatorial latitudes during magnetic storm periods and their effects on F region ionosphere.

125th Geological Society of America Annual Meeting, October 27-30, 2013, Colorado USA

Sinha, Anup K. and R.K. Srivastava

Geochemistry of distinct mafic dykes from the Damodar valley Gondwana basins and Chhotanagpur Gneissic Terrain, Eastern India: implications for their petrogenesis and tectonic setting.

Acoustics 2013 New Delhi "Technologies for a Quieter India", November 10-15, 2013, NPL, New Delhi

Lal, M.

Sound speed simulation in the earth's atmosphere.

First Cospar Symposium, Bangkok, 11-15 November 2013, Thailand

Kakad, A.P., Yoshiharu Omura and **B. Kakad**

One-dimensional fluid simulation of electrostatic solitary waves and validation of the nonlinear fluid theory.

Lakhina, G.S., B. T. Tsurutani and O. P. Verkhoglyadova

Radiation Belt Electron Precipitation due to cyclotron interaction with coherent chorus subelements.

Lakhina, G.S., S. V. Singh, A. P. Kakad and J. S. Pickett

Electron-acoustic solitons and double layers in the plasma sheet boundary layer.

Singh, S.V., **G.S. Lakhina** and R. Bharuthram

Electron-acoustic solitary waves and double layers in presence of non-thermal electrons and a warm electron beam.

International CAWSES-II Symposium, November 18-22, 2013, Nagoya, Japan

Bhaskar, A. and **G. Vichare**

The response of day side equatorial ionosphere to the southward and northward IMF Bz turnings.

Singh, S.V., **A.P. Kakad**, **G.S. Lakhina** and Y. Omura

Quasi-electrostatic instability due to high-energy tail distribution in the ring current region.

Singh, R., Ajeet K. Maurya, R. Selvakumaran and **B. Veenadanri**

Response of the equatorial and low latitude D-region ionosphere to the solar flares of solar cycle 24.

Sripathi, S.

Response of ionospheric TEC to intense X-class solar flares: case studies.

Sripathi, S., S. Banola, B. Veenadhari and **K. Emperumal**

On the role of Pre-Reversal Enhancement (PRE) and EEJ strength in generation of ionospheric plasma irregularities over Indian region.

Veenadhari, B., S. Mukherjee, B.D. Kadam, Sandeep Kumar, S. Gurubaran and **G.S. Lakhina**

Extreme space weather events as seen in the historical geomagnetic records at Colaba Observatory, India.

3rd International Conference on Precambrian Continental Growth and Tectonism (PCGT-2013), November 23-26, 2013, Department of Geology, Institute of Earth Sciences, Bundelkhand University, Jhansi, India

Singh, Vinod K. and **S.K. Patil**

Tectonic evolution of northern part of Bundelkhand craton: Anisotropy of magnetic susceptibility application.

American Geophysical Union (AGU) Fall Meeting, 9-13 December 2013, San Francisco, USA

Singh, A. K., S. Saini, R. Rawat, **Ashwini K. Sinha, A. Dhar** and E. Echer

Substorm Electrojet Dynamics in the Southern Auroral Region: Dependence on the Solar Illumination and IMF Conditions.

International Conference on Recent Developments in Stratigraphy (ICRDS-2013), December 14-16, 2013, Deccan Education Society's Fergusson College Pune, India

Erram, V.C., S.P. Anand and **M. Rajaram**

Tectonic framework of Eastern Continental Margin of India (ECMI) from magnetic data.

Regional Conference on Radio Science, January 2-5, 2014, Pune, India

Kakad, A.P., **B. Kakad** and Yoshiharu Omura

Effect of trapped electrons on the propagation of ion acoustic solitary waves.

Bagiya, Mala S., R. Sridharan, S. Sunda, Rajkumar Choudhary and Tarun K. Pant

Critical assessment of the forecasting capability of temporal evolution of L-band scintillation over Indian region.

Devanandhan, S., S. V. Singh, G. S. Lakhina and R. Bharuthram

Small amplitude electron acoustic solitons in a weakly magnetized plasma with superthermal electrons.

Gokani, Sneha A. and **R. Singh**

Propagation Characteristics of Multi-Station Recorded Low Latitude Whistlers.

Parihar, N. and **S. Gurubaran**

Recent Observations of OI 630 nm Nightglow Near the Crest of Equatorial Ionization Anomaly over India.

Yadav, V., B. Kakad, C.K. Nayak, G. Surve and **K. Emperumel**

Discrepancies in occurrence of blanketing Es-layer (Esb) over equatorial region during peculiar minimum of solar cycle-24.

Sripathi, S., S. Banola, B. Veenadhari and **K. Emperumal**

On the role of Pre-Reversal Enhancement (PRE) and EEJ strength in generation of ionospheric plasma irregularities over Indian region.

Venkatesham, K., Ajeet K. Maurya, R. Selvakumaran, B. Veenadhari and **R. Singh**

Effects of solar flare Events of Solar cycle 24 on low latitude D-region ionosphere.

International Symposium on Integrated Water Resources Management, February 19-21, 2014, Kozhikode, India

Gopinath, G., T. R. Reshmi, A. S. Hameed, M. Parveenbabu, **P. S. Sunil** and **Rahul Rawat**

Ionic composition of a high altitude lake – the Schirmacher Oasis, East Antarctica.

Gopinath, G., T. R. Reshmi, A. S. Hameed, M. Parveenbabu, **P. S. Sunil** and **Rahul Rawat**

Chemistry of a polar lake – the Larsemann Hills in Antarctica.

7th International Conference on Physics of Dusty Plasma (ICPDP2014), March 3-7, 2014, New Delhi,India

Lakhina, G.S.

Ion acoustic solitons/ double layers in two - ion plasma revisited.

6th VERSIM workshop, January 20-23, 2014, Dunedin, New Zealand

Singh, R., Sneha A. Gokani, Ajeet K. Maurya, B. Veendhari, Sushil Kumar, Morris B. Cohen and Janos Lichtenberger

Geo-location and Propagation Features of Very Low latitude Whistlers (L=1.08).

Singh, R., Ajeet K. Maurya, D.V. Phani Kumar, Sushil Kumar and **B. Veenadhari**

Wave-like signatures in the low-mid latitude D-region ionosphere associated with 22 July 2009 Total Solar Eclipse.

Singh, R., Ajeet K. Maurya, B. Veendhari, Sneha A. Gokani, Morris B. Cohen and Torsten Neubert

First Observations of TLE's and Gigantic Jet in Indian Sub-continent.

DEPUTATIONS/VISITS ABROAD

Name	Country visited	Duration	Conference/workshop/symposium
Shri Ponraj, M.	Italy	June 17-28, 2013	Workshop on "Earthquake Tectonics and Hazards on the Continents" conducted by ICTP at Trieste.
Dr. Sunil, P.S.	Australia	June 24-28, 2013	10th Annual Meeting, Asia Oceania Geosciences Society (AOGS), held in Brisbane.
Dr. Sinha, Ashwini K.	Australia	June 24-28, 2013	10th Annual Meeting, Asia Oceania Geosciences Society (AOGS), held in Brisbane.
Dr. Tulasiram, S.	Australia	June, 24-28, 2013	10th Annual Meeting, Asia Oceania Geosciences Society (AOGS), held in Brisbane.
Dr. Tulasiram, S.	Taiwan	July 12-17, 2013	CAWSES workshop on Whole Atmospheric Coupling during solar cycle 24
Prof. Rajaram, M.	Mexico	August 26-31, 2013	Meeting of the International Association of Geomagnetism and Aeronomy (IAGA), held in Merida, Mexico.
Prof. Gurubaran, S.	Mexico	August 26-31, 2013	Meeting of the International Association of Geomagnetism and Aeronomy (IAGA), held in Merida, Mexico.
Dr. Veenadhari, B.	Mexico	August 26-31, 2013	Meeting of the International Association of Geomagnetism and Aeronomy (IAGA), held in Merida, Mexico.
Dr. Sinha, Anup K.	USA	October 27-31, 2013	125th Geological Society of America Annual Meeting in Colorado.
Prof. Gurubaran, S.	Japan	November 18-22, 2013	International CAWSES-II Symposium, held in Nagoya, Japan
Dr. Sripathi, S	Japan	November 17-24, 2013	International CAWSES-II Symposium, held in Nagoya, Japan
Shri Bhaskar, A.	Japan	November 18-22, 2013	International CAWSES-II Symposium, held in Nagoya, Japan
Dr. Singh, Rajesh	Japan	November 18-22, 2013	International CAWSES-II Symposium, held in Nagoya, Japan
Dr. Singh, Rajesh	New Zealand	January 20-23, 2014	6th VERSIM workshop

Name	Country visited	Duration	Conference/workshop/symposium
Foreign Assignments			
Dr. Vichare, Geeta	Japan	February 28-March 08, 2014	RISH, Kyoto University, Kyoto, Japan as a part of IIG-WDC Kyoto, Japan project
Dr. Veenadhari, B.	Japan	February 29-March 13, 2014	RISH, Kyoto UniversityJapan as a part of IIG-WDC Kyoto, Japan project
Dr. Tulasiram, S.	Japan	March 09-15, 2014	Invited for scientific discussions at Kyushu University, Japan
Prof. Singh, Satyavir	South Africa	April13-June 08, 2013	University of the Western Cape, Bellville and Hermanus Magnetic Observatory, Hermanus, South Africa under Indo-South Africa Bilateral Project " Linear and nonlinear studies of fluctuation phenomena in laboratory, space and astrophysical plasmas"
Prof. Singh, Satyavir	Japan	August 01-January 31, 2014	Visiting Associate Professor, RISH, Kyoto University, Kyoto, Japan
Dr. Kakad, A. P.	Japan	Sept 2011-Sept 2013	JSPS Post-doctoral fellowship to Research Institute for sustainable humanosphere, Kyoto University
Dr. Sripathi, S.	Taiwan	September 19-25, 2013	India-Taiwan joint collaboration project
Dr. Tulasiram, S.	Taiwan	September 19-October 19, 2013	India-Taiwan joint collaboration project
Dr. Singh, Rajesh	Japan	November 09-17, 2013	RISH, Kyoto University, Japan under DST sponsored India-Japan Cooperative Science Program Research Project
Antarctic/Arctic Expeditions			
Dr. Sunil P.S.	Norway (Arctic)	August 01-September 05, 2013	Participation in Scientific Expedition to Svalbard, Arctic region.
Shri K. Jeeva	Maitri, Antarctica	Antarctic Winter	Member of Indian Antarctic Expedition and Station Commander at Maiti.
Shri Jayanta K. Behera	Maitri, Antarctica	Antarctic Winter	Member of Indian Antarctic Expedition
Shri Pritamaya Patro	Bharati, Antarctica	Antarctic Winter	Member of Indian Antarctic Expedition
Shri Sachin M Labde	Maitri, Antarctica	Antarctic Summer	Member of Indian Antarctic Expedition

DISTINGUISHED VISITORS

Dr. Ulrich Blaha

ERDS-tec, Germany visited the Environmental Magnetism laboratory during December 10-23, 2013 for collaborative research.

Dr. Carol Finn

President American Geophysical Union visited IIG during December 23-26, 2013 and delivered a lecture on *"Magnetic and EM studies on volcanic landslides"*. During her stay, she also visited the Environmental Magnetism laboratory.

Dr. Raghunath Acharya

BARC, Mumbai visited the Environmental Magnetism laboratory on December 28, 2013.

Dr. Sunanada Basu

Institute for Scientific Research at Boston College, Boston, USA, February 24-25, 2014.

Dr. Shimul K. Maharaj

South African National Space Agency. (SANSA) Space Science Directorate, Hermanns, South Africa, February 23-March 2, 2014.

Prof. R. Bharuthram

University of Western Cape (UWC), South Africa, February 27-March 2, 2014

Prof. Shin Yi Su and **Prof. Lung Chi Tsai**

National Central University, Taiwan, 12-17 January, 2014 under India-Taiwan Science and Technology cooperation project (GITA/DST/TWN/P-47/2013).

Padmashree M. Natarajan

Chairman, Board of Governors, IIT Mandi visited EGRL on February 27, 2014.

Frank Verheest

Professor, Universiteit Gent, Belgium, visited IIG during 12-22, March 2014.

HONOURS AND AWARDS

Anand, S.P.

Invited to participate in the two day workshop on "Dharwar to Deccan Traps: An Integrated Geoscientific Approach" jointly organized by Department of Earth Science, SRTM University Nanded and the Indian Geophysical Union during August 29-31, 2013.

Recognized as Ph.D. guide by Andhra University, Visakhapatnam.

Anil Kumar, C. P.

Inaugurated the symposium on "Future alternating current energy sources" and delivered the key note address at Einstein College of Engineering, Sir C.V.Raman Nagar, Abhishekpetti, Tirunelveli on October 11, 2013.

Presided over the Science talent meet and science fair -2013, at District Science Centre, Tirunelveli and delivered the presidential address "Science for humanity" on August 30, 2013.

Basavaiah, N.

Member, Board of Studies in Geophysics, Andhra University, Waltair.

Guest Editor, Research Trends in Smart Material, *International Journal Chemical and Physical Sciences,* Special Issue, Volume 3, 2014.

Bhattacharyya, A.

Awarded J. C. Bose National Fellowship.

Member, Research Council, CSIR-NGRI, Hyderabad.

Member, International Organizing Committee, Asia-Pacific Radio Science Conference (APRASC-2013) held in Taipei, Taiwan during September 3-7, 2013.

Guest Editor of a Special Issue of the Journal of Atmospheric and Solar Terrestrial Physics on 'Recent Advances in Equatorial, Low- and Mid-latitude Aeronomy' published by Elsevier in October 2013.

Chair, Scientific Organizing Committee, Regional Conference on Radio Science, Pune, January 2-5, 2014.

Erram, V.C.

Recognized as Ph.D. guide by Shivaji University, Kolhapur.

Gokani, Sneha

Third Prize in Students Paper Competition in Regional Conference on Radio Sciences (RCRS), January 2-5, 2014, Pune, India

Gupta, G.

Associate Editor to the editorial board for the AGGS Journal of Groundwater Research for the period 2013-2016.

Recognized as Ph.D. guide by Shivaji University, Kolhapur.

Gurubaran, S.

Organized one session at XII Scientific Assembly of IAGA held at Mexico during August 26-31, 2013 .

Co-convener for one special session at International CAWSES-II Symposium held at Nagoya, Japan during November 18-22, 2013

Jeeva, K.

Selected as Station Commander of Maitri Station. Shri Jeeva is wintering at Antarctica for the fifth time and selected as Station Commander for the second time.

Lakhina, G.S.

Member of Scientific Program Committee of the First COSPAR Symposium, held at Bangkok, Thailand during November 11-15, 2013

Main Scientific Organizer (MSO) for the *Special Session 6. Ionosphere, Magnetosphere and Space Physics* during First COSPAR Symposium, held at Bangkok, Thailand during November 11-15, 2013

Co-convened the special session *ST05: Inner/outer frontiers of terrestrial magnetosphere and of magnetized /unmagnetized planets,* in 10th Annual Meeting, Asia Oceania Geosciences Society (AOGS), held in Brisbane during June 24-28, 2013.

Bagiya, Mala

INC-URSI Young Scientist Award, Regional Conference on Radio Science, January 2-5, 2014, Pune, India.

Thomas, Neethal

Received best poster award at 18th National Space Science Symposium (NSSS - 2014), held at Dibrugarh University, Assam during 29 January – 1 February 2014.

Rajaram, M.

Invited by SPG to chair a session on "Non seismic methods and case histories" at its 10th Biennial International Exposition with the theme *"Changing Landscape in Geophysical Innovations"* held at Kochi during November 22-25, 2013.

Sathishkumar, S.

Received best paper (oral presentation) award at 18th National Space Science Symposium (NSSS - 2014), held at Dibrugarh University, Assam during January 29-February 1, 2014.

Singh, S. V.

Convener, Workshop on "Fluctuation Phenomena in Space Environment", SANSA, Hermanus, South Africa (May 30-31, 2013).

Chaired a session in theWorkshop on "Fluctuation Phenomena in Space Environment", SANSA, Hermanus, South Africa (May 30-31, 2013).

Sinha, Ashwini K.

Member of Indian Geophysical Union.

Nominated as Fellow, Indian Geophysical Union during January 2014.

Co-convener of the session **ST23-03: ULF, ELF and VLF Wave Probes of the Magnetosphere and Ionosphere** in10th Annual Meeting, Asia Oceania Geosciences Society (AOGS), held in Brisbane during June 24-28, 2013.

Chaired a session on **ULF, ELF and VLF Wave Probes of the Magnetosphere and Ionosphere in** 10th Annual Meeting, Asia Oceania Geosciences Society (AOGS), held in Brisbane during June 24-28, 2013.

Sripathi, S.

Convened a parallel session (PS3) in National Space Science Symposium at Dibrugarh, Assam, India during January 29-February 01, 2014.

Member of the selection committee for the best paper award in PS3 session ofNational Space Science Symposium at Dibrugarh, Assam, India during January 29-February 01, 2014.

Tulasiram, S.

Co-convened the parallel session on Sun-Earth System Response to Extreme/transient Solar and Seismic Events and Space Environment (ST01-13-15) at AOGS Annual Meeting 2013, Brisbane, Australia during June 24-28, 2013.

Chaired a session on Sun-Earth System Response to Extreme/transient Solar and Seismic Events and Space Environment (ST01-13-15) at AOGS Annual Meeting 2013, Brisbane, Australia during June 24-28, 2013.

Veenadhari, B.

Member of Indian Geophysical Union (IGU).

Selected for Executive Council of IGU (2013-2015).

TRAINING IMPARTED

Dr. Gautam Gupta

Guided the dissertation of Ms. Varsha Patil, a student of Gopal Krishna Gokhale College, Shivaji University, Kolhapur on the topic"*Assessment of seawater intrusion using electrical soundings in west coast Maharashtra*" towards the partial fulfillment of M.Sc. degree in Geology during December 2, 2013-January 13, 2014.

Dr. S.P. Anand,

Guided Mr. Sivakumar, M., from Department of Geophysics, Andhra University College of Science and Technology for his M.Sc. dissertation work on *"Aeromagnetic signatures of the Pranhita-Godavari Gondwana Graben"* during April-May 2013.

Guided Ms. Saritha, M.P.,from Department of Geology and Geophysics, Cochin University of Science and Technology for her M.Sc.dissertation work on*"Crustal Structure and Tectonics of the Cauvery Basin from Aeromagnetic Data"*, during January-June 2013.

Guided Mr. Sourabh B. Jadhav from Shivaji University, Kolhapur for his M.Sc. dissertation on *"Crustal Magnetic Anomaly over a part of Chattisgarh Basin"*during December 2013-January 2014.

Guided Ms. Siji Devassi from Department of Geotechnology, M.S. University Tirunelveli for her dissertation work on *"Study of the free air gravity anomalies over the Laccadive basin"* during January-March, 2014.

Guided Mr.Nideesh from Cochin University of Science and Technology for his M.Sc. dissertation on *"Qualitative interpretation of aeromagnetic data over a part of Meghalaya Plateau"*during January-March, 2014.

Guided Ms. Radhika for her dissertation on *"An overview of different heights used in Geodesy"* as a part of IIG course work for research scholars.

Dr. P.B.V. Subba Rao

Guided two students from ISM, Dhanbad for M. Sc. dissertation work on the topics *"EM induction studies in Saurashtra region"* (Supriyo Paul) and *"Geophysical studies in Saurashtra region"* (Abir Banerjee) during the period May to June 2013.

Dr. C. P. Anilkumar

Guided two post graduate students from School of Pure and Applied Physics, Mahatma Gandhi University, Kottayam, Kerala for their final semester project at EGRL, Tirunelveli.

Guided two M.Phil. students from Dept. of Physics, Nesamony Memorial Christian College, M.S. University for their final semester project work at EGRL, Tirunelveli.

Dr. K. Vijaya Kumar

Guided two students, Monika Srivastava and Nitin Kumar Singh as summer trainees from Department of Environmental Science, Veer Bahadur Singh Purvanchal University, Jaunpur for 45 days from June 15, 2014.

Dr. S.K. Patil.

Trained two Research scholars of BHU, Varanasi on *"AMS techniques to investigate the structural configuration of Almora crystalline rocks, Pitoragarh, Uttaranchal",* during November-December, 2013 .

Dr. P. S. Sunil

Guided the dissertation of Ms. M. Mishya from Cochin University of Science and Technology towards the partial fulfillment of the M. Sc. Degree in Marine Geophysics on the topic *"Study of the Reservoir Induced Seismicity and Crustal stress pattern of the Koyna-Warna region, Western Maharashtra"* during January-July 2013.

Guided Mr. N. S. Morti from Shivaji University for his M. Sc. project on *"Study of the co-seismic Crustal deformation due to the 11th March 2011 Thohoku Earthquake (Mw=9.0), Japan)"*during December 2013- January 2014.

Guided a student Ms. P. S. Sanila from Manonmaniam Sundarnar University for the M. Sc. Applied Geophysics project*"Study of the Co-Seismic Deformation Characteristics of 11th March 2011 Thohoku Earthquake from Geodetic GPS derived Velocity"* during February-March 2014.

Dr. Rajesh Singh

Guided one M.Sc. (Environment Science) student from Purvanchal University, Jaunpur for summer dissertation.

Guided one B.Sc. (Third year) student from Banaras Hindu University for summer dissertation.

Dr. Ashwini K. Sinha

Guided Ms. Shilparani Sahoo for her dissertation on *"Theoretical and observational studies on geomagnetic pulstions"* as a part of IIG course work for research scholars.

Guided Ms. T. Sujitha from Andhra University for her dissertation on *"Sources of the post sunset pulsations at low latitude"* towards the partial fulfillment of M.Sc. degree in Physiscs (Space Science).

Dr. V.C. Erram

Guided a student Ms. Minaj B. Shikalgar from Gopal Krishna Gokhale College, Shivaji University, Kolhapur for M.Sc. dissertation on the topic *"Ground magnetic data interpretation over Gudivada depression, part of Krishna-Godavari basin, Andhra Pradesh"* during the period December 2013-January 2014.

Prof. N. Basavaiah

Imparted training to more than 10 students from Universities of Andhra (*Environmental magnetism of Kolleru lake*), Cochin (P*alaeomagnetism of coastal dyke swarm in Deccan Traps near Mumbai),* Mumbai *(Relationship between magnetic and dielectric measurements of synthetic compounds),* D.Y. Patil College of Engineering, Kolhapur (*Synthesis of cobalt ferrite nano-particles using magnetotactic bacteria for biomedical applications*), M.S. University of Baroda (*Sediment provenance, pathway and sink potential of inner Gulf of Kachchh coast*), Annamalai (*Mineralogical, geochemical and environmental magnetic studies on marine sediments off Visakhapatnam coast, Bay of Bengal, India*) and Kumaon (*Magnetic and geochemical studies of the Himalayan terrain*) for their Ph.D. and M.Sc. dissertation projects in environmental magnetic studies and synthesis of nano ferrites for biomedical topics.

Trained many scientists/students from BARC, Visakhapatnam NSTL, Udaipur HZL and ONGC in *rock magnetic and spectroscopic analysis of synthetic and natural materials*.

Dr. M. Lal

Guided Mr. A. Kalam, a student of VBS Purvanchal University, Jaunpur for his dissertation on *"Diurnal Changes in Geomagnetic field variation during severe Earthquake".*

Guided Ms. Neha Tiwari and Ms. Sneha Tripathi, students from Nehru Gram Bharti University, Allahabad for their dissertation on *"Eddy Diffusion Coefficient for N2O in the middle atmosphere".*

Shri M. Ravi Kumar

Guided a student Ms. S.H. Ahalya Thampi of Manonmaniam Sundaranar University, Tirunelveli on the topic *"Gravity anomalies, isostasy over Himalaya- Tibet"* as a part of M.Sc. dissertation work during January-February 2014.

Instrumentation Division

Two final year B.E. students of Mumbai University have been guided at the **Instrumentation Division** for completing their technical projects. These students have redesigned the 25 Hz filter used in the Proton Magnetometer for improving the signal to noise ratio. This unit has been tested and submitted as their final year project report.

PARTICIPATION IN SPECIALIZED WORKSHOPS/ TRAINING COURSES

Shri B.N. Shinde, Shri Priyesh Kunnummal and **Dr. S.P. Anand** received two days training in the handling, field operation and processing of Geomax Differential GPS unit during April 2013 at IIG campus by technical expert from Geomax.

Shri M. Ponraj participated in the worksop on "Earthquake Tectonics and Hazards on the Continents" held at ICTP, Trieste, Italy during June 17-28, 2013.

Shri Sandeep Sathian attended the "Winter School in Geomathematics", sponsored by Science and Engineering Research Board, SERB, DST, Govt. of India, organised at Wadia Institute of Himalayan Geology, Dehradun during December 16-30, 2013.

POSTGRADUATE/Ph.D. DEGREE AWARDED/ SUBMITTED

Mr. S. Devanandhan submitted Ph.D. thesis on 31st December 2013, to Mumbai University entitled *"Study of some linear and non linear phenomenon in space plasmas"* under the guidance of **Prof. S.V. Singh**.

Mr. Ajeet K. Maurya was awarded Ph.D. Degree in Physics from Mumbai University on the thesis entitled *"ELF/VLF studies of ionosphere and magnetosphere electromagnetic phenomenon in low latitude region"* under the guidance of **Dr. R. Singh.**

Mr. C.K. Nayak was awarded Ph.D. degree of the Mumbai University on the thesis entitled *"Study of the variability of equatorial & low latitude ionosphere in the Indian region using radio waves"* under the guidance of **Prof. S.V. Singh**.

Ms. B. Remya submitted Ph.D. thesis on 12th August 2013, to Mumbai University entitled *"Beam and temperature driven plasma instabilities in the solar wind and the Earth's magnetosphere system"* under the guidance of **Prof. R.V. Reddy**.

Mr. R.O. Rufai was awarded Ph.D. degree of the University of the Western Cape, Belville, South Africa on the thesis *"Non-Linear Wave Phenomena in Space Plasmas"* under the guidance of Prof. R. Bharuthram (University of the Western Cape, Belville, South Africa), **Prof. S.V. Singh** and **Prof. G.S. Lakhina.**

Mr. Md. Arif has been awarded the Ph.D. degree of Mumbai University on the topic*"Rock magnetism and Palaeomagnetism of meteorite impact craters in India"* under the guidance of **Prof. N. Basavaiah** in March 2014.

Mahesh N. Shrivastava has been awarded with Ph.D. degree from University of Mumbai on the topic *"Estimation of Strain distribution of the seismogenic regions of India, from GPS measurements; Numerical modeling, interpretations and implications"* under the guidance of **Dr. C. D. Reddy** on September 21, 2013.

P.K. Das has submitted a thesis entitled *"Magnetic investigations of urban pollution at Mumbai and Nashik, Maharashtra, India: mineral magnetic method as a pollution proxy"* under the guidance of **Prof. N. Basavaiah** for the award of Ph.D. degree from University of Mumbai in February 2014.

OFFICIAL LANGUAGE (HINDI)

In compliance with the provisions of the Official Languages Act, Rules made there under, Annual Programme and other directives issued from time to time by the Department of Official Language, the Institute regularly undertakes some important and special activities to increase the progressive use of official language Hindi among its members.

The Institute organized 'Hindi Mah' during September-October, 2013. The Hindi competitions organized during this period included Computer Typing, General Knowledge, Crossword, Essay Writing and a new competition viz. Word Construction from the given prefix or suffix, which were well attended by the members. 'Hindi Mah' concluded with a prize distribution function, in which Chief Guest Dr.(Smt.) Rita Kumar, Retd. Chief General Manager of Cotton Corporation of India and former Secretary, TOLIC, Navi Mumbai, gave away the prizes to the winners and addressed the gathering.

Director-in-charge welcoming the chief guest Dr. (Mrs.) Rita Kumar during valedictory function of Hindi Mah Celebration

Chief guest Dr. (Mrs.) Rita Kumar along with Director-in-charge and Rajbhasa Adhikari during valedictory function of Hindi Mah Celebration

Prize winner of a Hindi competition during Hindi Mah Celebration

She emphasized the need for concerted efforts from each and every member of the Institute towards progressive use of official language Hindi.She also stated that translation based work will not help alone in achieving the targets set by the Government.Therefore, the staff should always be encouraged through various schemes to do their work in Hindi. Prof. S. Gurubaran, Director Incharge appreciated the efforts put in by staff members in doing their day-to-day official work in Hindi. He also gave away prizes to some of the winners.

Hindi House Magazine "SPANDAN" was published as a regular activity, which includes scientific and technical articles as well. The magazine is sent to various scientific and educational institutes of the country.

During the year, four Hindi Workshops were organized on different topics, in which a total of 65 members participated.

Under the incentive scheme, 9 staff members of the Institute were awarded with cash prize for doing their official work in Hindi during the Annual Day Celebrations.

Hindi Officer and Sr. Hindi Translator continued as members of the editorial board of Hindi Magazine 'Samanvaya' being jointly brought out by the member organizations of TOLIC, Navi Mumbai.

Release of in-house Hindi magazine SPANDAN

Director, Rajbhasha Adhikari, Hindi Officer and Sr. Hindi Translator of the Institute attended various meetings/ seminars held under the aegis of TOLIC, Navi Mumbai and other voluntary organizations. Two staff members of the Institute received 1st and 3rd prize in Crossword Competition.

Ms. Manju Singh, Sr. Hindi Translator was felicitated by Mumbai based cultural organization 'Ashirwad' for her contribution towards implementation of official language policy in the Institute.

PUBLIC OUTREACH

Interaction with students

Vigyan Manthan Yatra 2013-14 under M.P Mission Excellence Programme

The Government of Madhya Pradesh has initiated a programme called M.P Mission Excellence, under which meritorious students selected from all over the state are nurtured for taking up career in science. The programme is implemented over the last six years successfully. Under this programme about 125 meritorious students, 10 teachers and 5 officials of MPCST (140 persons) visited the Institute on 14 January 2014. The students were explained the science of Geomagnetism through colorful posters. Two talks were delivered to students on the topics "IIG's scientific activities" and "Basics of Geomagnetism" by **Shri A. Dhar.**

The students also had an interaction with the Research Scholars of the Institute for a question-answer session.

D.Y. Patil Polytechnic College, Nerul, Navi Mumbai

Nearly 160 final year students of Electronics and Electronics & Telecommunications branches and 4 faculty members of D.Y. Patil Polytechnic College, Nerul, Navi Mumbai visited the Institute on January 17, 2014 under educational visit programme. Two talks were delivered to students as follows:

i. **Shri A. Dhar** delivered a talk on "Basics of Geomagnetism"

ii. **Dr. (Ms.) Mala Bagiya** delivered a talk on "GPS Navigation system"

The students also visited Instrumentation, Environmental Magnetic and Geodesy Laboratories.

Institute's scientist Dr. (Ms.) Mala Bagiya delivering scientific lecture to a group of college students

Zila Parishad School, Ambernath, District Thane

Forty eight Students and 5 Teachers of Zila Parishad School, Ambernath, District Thane, visited Magnetic Observatory Alibaug under educational visit programme. The students were given a tour of the Observatory and explained the working of various instruments and importance of geomagnetic studies. **Shri A. Dhar** explained the the basics of Geomagnetism to the visiting students.

Institute of Sciences, Mumbai

Twenty two students of final year M.Sc. (Physics) and four faculty members visited the Institute as educational trip to get acquainted with the "Science of Geomagnetism and allied fields" on February 12, 2014. Two talks were delivered to the students as follows:

i. **Dr. Ashwini K. Sinha** delivered a talk on "Fundamentals of Geomagnetism"

ii. **Dr. (Ms.) Mala Bagiya** delivered a talk on "Space weather - recent advances"

The students visited the Environmental Magnetism and Geodesy Laboratories to understand the operation of various equipments used at the Institute.

Don Bosco Institute of Technology, Mumbai

Seventy five students of Electronics & Telecommunication Branch (II year) and 3 faculty members visited the Institute on an educational tour on February 14, 2014. The students were explained the "Science of Geomagnetism" through colorful posters. A talk on "Introduction to Geomagnetism" was delivered by **Shri A. Dhar** to visiting students. The students also had a fruitful interaction with the Research Scholars for a question-answer session.

Wilson College, Mumbai

Shri A. Dhar delivered a talk on "Basics of Geomagnetism and studies conducted at Antarctica" to 2nd and final year science students of Wilson College, Mumbai on February 18, 2014. Shri Dhar gave away prizes and trophies to meritorious students of the college.

Sangammer Science College, Sangammer, Nasik

Sixty students of 3rdyear B.Sc. (Physics) and five faculty members of Science College, Sangammer, Nasik visited the Institute on an educational trip on February 25, 2014. The students were explained the "Science of Geomagnetism &allied fields" through colorful posters. The students had an interactive session with the Research Scholars to clarify various doubts.

Science Week Celebrations at IIG, Panvel

The Science Week was celebrated at the Institute from February 20-27, 2014 with an open house exhibition of colorful posters depicting the "Science of Geomagnetism & related fields". Various scientific models and instruments were displayed for the benefit of students. The theme of the Science Day – 2014 was "**Fostering Scientific Temper**".

Various events and competitions were organized for the students and teachers prior to open house exhibition. The competitions for students were as follows:

i. Essay writing competition for various categories of the students on the theme "Scientific contributions of Sir C.V. Raman"

ii. Elocution competition for various categories of students on the theme "India's Mars Mission"

iii. Sit & Draw competition for various categories of students on the theme "Space Applications"

iv. Power Point presentation by various categories of students on the theme "South Pole"

v. Power Point presentation by Teachers on the theme "Fostering Scientific Temper"

School students participating in the essay writing competition during Science Week 2014

A school student participating in elocution competition during Science Week 2014

School kids participating in 'Sit and draw' competition during Science Week 2014

More than 700 students and 25 teachers participated in the competitions and were awarded prizes and trophies. The science exhibition was visited by more than 700 students and people from all walks of life. Regular spot Quiz programmes were held for students visiting the exhibition and winners were given prizes.

The concluding Science Day function was held on February 27, 2014. The Science Day talk was delivered by Shri Ramesh Koul, Head, Astrophysical Sciences Division, Bhaba

Director addressing teachers and students of different schools during Science Week 2014

Winners being awarded with memento and certificates during Science Week 2014

Winners being awarded with memento and certificates during Science Week 2014

Atomic Research Centre, Mumbai on the topic "TeV Astronomy – A new window to the Universe", who was also the Chief Guest of the function.The valediction function was held on the afternoon and trophies and cash prizes were awarded to winning participants in the various competitions.

A school teacher being awarded with memento and certificates during Science Week 2014

Science Day Celebrations at KSKGRL Allahabad

As one of the routine yearly scientific activity for scientific outreach at Dr. K.S. Krishnan Geomagnetic Research Laboratory (KSKGRL) Allahabad, **science day celebrations** were organized. This year it was organized for a period of two days, **28th of February and 1st March 2014.** As in the previous years, the schedule of celebrations were the audio-visual presentation in the conference hall, poster display of the institute's activities and demonstration of scientific instruments. The theme of this year's science day, "Fostering Scientific Temper", was also conveyed to the young minds with simple examples of scientific reasoning. Due to overwhelming response from students in previous years, this year too schools with under-privileged children were invited.

Scientific exhibits on display during Science Day 2014 at KSKGRL, Allahabad

A total of about 500 students from seven schools participated in the event. The highlight of this year's activity was the organizing of quiz and debate competitions on each of the days. Two students representing from each school were

Winners being awarded with prizes during Science Day 2014 at KSKGRL, Allahabad

Group of school students along with staff members at KSKGRL, Allahabad during Science Day 2014

invited for the competitions. A few questions were kept open for the students in audience, bringing in more enthusiasm amongst them. The celebrations were well-organized and in disciplined manner and wide topics related to geo-science and space science were covered. A 30 minute power point based lecture with all slides exclusively in Hindi was prepared keeping in view the Hindi medium students, and thus in popularization of science among common people. To encourage the students, prizes were given to the winners along with the participation certificates.

COMPUTER FACILITIES

The Computer Centre continues to provide computational, network infrastructural facilities and services to the Institute's user community. During the year, following activities were undertaken to install, expand and upgrade the network infrastructure at the Institute.

IIG has planned to establish High Performance Computing (HPC) center at Panvel campus. In this context, Institute has started the procurement of 256-core HPC cluster. This HPC center will provide the computational resources required by IIG researchers to run various simulation codes for computer simulation/modeling of geophysical processes in space as well as ground. Considering round the clock operation of HPC cluster, it is also planned to have high-density smart row cooling system for the HPC cluster.

The Institute's new website has been developed and launched recently. Several new features such as, online tender and jobs advertisement information solution are implemented on the new website. IIG library website is also operational on the existing network.

Wireless LAN with user authentication is extended to new auditorium and new building in the main campus, where users can access the computer network. During the year, another 30 Mbps Internet bandwidth line was acquired from the MTNL. This line will be used for the library services, video conferencing and online data transfer between the main campus, regional centers and the observatories.

Mathematical, numerical and visualization application software like IDL, Mathematica, Origin, MATLAB, Lahey FORTRAN etc. available through appropriate license schemes are procured, upgraded and administered by Computer Centre as per the requirements of the students, scientists and staff for scientific and technical computation. The Computer Centre runs a Help Desk for all users as a part of its day-to-day activities.

LIBRARY AND DOCUMENTATION

Library

The library was committed to meeting the needs of staff and students by providing timely user service, supporting research, learning and teaching, and ensuring that these facilities and services are accessible to everyone. The services were extended to outside users from universities and other organizations also.

During the year, the library added 337 books on areas of research within the institute, and 115 reprints and conference papers. 142 bound volumes and 2 toposheets were added. 102 Hindi books were acquired that were subsequently donated to two schools for underprivileged children through SOSVA, an NGO. The library had an excellent usage statistics of the online library resources. It procured 78 documents on inter-library loan for its users and also provided documents to other libraries under this service. 35 new students from across the country visited and used the library for their various project and/or internship work.

Access to online resources to scientists and IIG regional centers and observatories was enabled via the Ezproxy server. Users were given three tiered access to all the publications by the institute scientists using the Ezproxy server, the Cd-server and the Web-OPAC. The library website further enhanced the services by providing access to all resources. Through the NKRC (library consortium of DST-CSIR laboratories), users have full text access to more than 20 publisher resources. All foreign journals were subscribed to in the online version and access to all these journals was given to all observatories and regional centers via the Ezproxy server. Print copies of only Indian journals were subscribed to. The conservation work of old journal volumes and old classic books was completed and a new conservation project of some important volumes was started. The library continued to train new library interns in all aspects of library work.

Documentation

Documentation continued all their support services to the scientists. During the past year, the work of scanning and digitizing the Ph.D. thesis by scientists of the institute was started. This work is still going on along with other routine services like, rendering help in preparation of posters, editing of photographs, designing/ layout of institute publications and photography of magnetograms.

SPECIAL EVENTS

One day workshop conducted at B.P Singh Memorial Auditorium, IIG on March 12, 2014

A one day workshop on ***"Recent trends on application of Geopotential fields to Solid Earth studies"*** was conducted in IIG, on March 12, 2014. The workshop was organized in order that specialists involved in gravity and magnetic surveys and interpretation could discuss methods and techniques under informal terms. Eight speakers from institutions like NGRI, GSI, AMD, IITB and IIG who were closely associated with the growth of Earth Science in India, particularly in the advancement of Geopotential studies in understanding the subsurface structures as well as for resource evaluation, were invited to deliver lectures during the workshop. The papers presented covered a wide range of spectrum right from ground magnetic studies through airborne, marine to satellite magnetic and gravity data. Topics that were addressed ranged from field surveys, data processing, numerical modeling, inversion and interpretation in gravity and magnetic methods, to a variety of case histories. The presentations were quite impressive. The workshop also discussed the future thrust areas in the Indian sub-continent and adjoining oceans where geopotential methods prove invaluable.

The workshop started with a warm welcome and remarks on the theme of the workshop by Dr. D.S. Ramesh, Director IIG, who was mainly responsible for such a unique one day workshop. This was followed by the formal inauguration by the Chief Guest Shri T.M.Mahadevan. He gave an inspiring lecture on "Challenges in Modelling Evolution of the Continental Lithosphere in the Indian Context". Dr.L.K.Das talked about the Utility of Potential field surveys in Mapping and exploration while Dr.V.M. Tiwari and Dr.Bijendra Singh respectively gave a detailed account on lithospheric structure beneath the Himalayas and the Deccan Volcanic province. They also discussed about the recent trends in the interpretation of the gravity data. A comprehensive account

on the recent developments in airborne geophysics was given by Dr.H.V.Rambabu. Dr.M.Radhakrishna talked about the Current Understanding on Structure and Tectonic Evolution of the Bay of Bengal using a combination of gravity and seismic data through a process oriented approach. The application of satellite and near surface magnetic field models to solid earth studies was presented by Dr.Hemant K. Singh while Prof. Mita Rajaram discussed the Future of geopotential field mapping and the need for a multi-platform approach. Vote of thanks was extended by Dr.Sunil P.S. The workshop was convened by Dr.S.P.Anand.

The workshop was unique as this may be one workshop in nearly half-a- decade which was exclusively dedicated to the geopotential studies. The workshop helped to improve our understanding in the field of potential field research as well as opened up new avenues and thrust areas in the Indian sub-continent for innovative thinking and application. The younger generation of scientists and students were particularly benefited from this one day workshop.

Inauguration of the one day workshop on "Recent trends on application of Geopotential fields to Solid Earth studies" by the Chief Guest Shri" T.M.Mahadevan

Deliberations by scientists during one day workshop on "Recent trends on application of Geopotential fields to Solid Earth studies"

Deliberations by scientists during one day workshop on "Recent trends on application of Geopotential fields to Solid Earth studies"

Prof. (Mrs.) Mita Rajaram discussing the future of geopotential field mapping and the need for a multi-platform approach during one day workshop on "Recent trends on application of Geopotential fields to Solid Earth studies"

An Impressive debut of IMPRESS-2014

The first **IMPRESS** programme was organized by Indian Institute of Geomagnetism (IIG), Navi Mumbai from March 19-21, 2014 at Dr. K.S. Krishnan Geomagnetic Research Laboratory (KSKGRL), Allahabad. The idea of the programme was born out of an informal discussion amongst the Director Prof. D. S. Ramesh and the research scholars of the Institute. The acronym '**IMPRESS**' which stands for '**Inspiring the Minds of Post-graduates for Research in Earth and Space Sciences**' was coined by the research scholars of the Institute. The main idea behind IMPRESS is to motivate young minds towards research, to experience the joy of discovery and to attract them towards a career in Earth and Space Sciences. IMPRESS would strive to make post

graduate students realise that research is indeed an exciting and sublime experience and an exclusive preserve of the chosen. This programme is designed to provide a rare opportunity for young students in India to learn about current areas of research in Earth and Space Sciences, through interaction and exposition sessions with IIG scientists and young researchers. Each year, IIG will be organizing IMPRESS programme at one of its several research centres. IMPRESS comprises of research motivation talks, plenary lectures, seminars and laboratory sessions related to the research activities of IIG.

Due to lack of time, the participation in this programme for this year was by invitation and it was heartening to see thirty young post graduate students including 10 girls and 20 boys from 10 different universities across India attending this program. The participating institutes were: Andhra University, Allahabad University, Banaras Hindu University, Cochin University of Science and Technology, Dibrugargh University, Guahati University, Saurashtra Univeristy, NIT Jalandhar, Mumbai University and Swami Ramanand Teerth Marathwada University, Nanded.

The event was formally inaugurated by the Director, Prof. D.S. Ramesh followed by a stimulating motivational talk. During the three days of the IMPRESS, four plenary lectures were delivered by Dr. S. TulasiRam, Prof. Satyavir Singh, Prof. D.S. Ramesh and Prof. S.K. Patil along with various lectures by members and young researchers of IIG. In the first talk, Dr. S. TulasiRam introduced the students into the world of Geomagnetism and Space Weather. Prof. Satyavir Singh, who is also the IMPRESS programme coordinator, gave the participants a brief introduction about the solar wind interaction with the magnetosphere. The third plenary talk by Prof. D.S. Ramesh provided glimpses of different processes within the earth whereas Prof. S.K. Patil illuminated

Director, faculties and participating students inaugurating IMPRESS-2014 at KSKGRL, Allahabad

Director welcoming the participants in the IMPRESS-2014 at KSKGRL, Allahabad

them with principles and applications of palaeomagnetism. In addition, there were two invited lectures; the first one by Dr. D.V. Phanikumar from Aryabhatta Research Institute of Observational Sciences (ARIES), Nainital, who discussed about various applications of RADARS for space studies and the second one by Dr. Ravi Kumar, Director-in-charge of Nehru Planetarium, Allahabad who literally took the students for a trip to the stars in the night sky.

Scientists of the Institute interacting with the participating students during IMPRESS-2014 at KSKGRL, Allahabad

On the first two days of the meet, the students were introduced to various techniques used to study the upper atmosphere and space weather phenomena. The laboratory sessions were organized under the leadership of Dr. Rajesh Singh, Local Organizing Committee chairperson at KSKGRL Allahabad, where the participants were first introduced to the working principles behind each experiment or instrument using power point presentations. The first laboratory session dealt with the study of the ionosphere using the radio waves by different techniques namely, Ionosonde, VHF scintillation receivers, and the VLF. The participants were exposed to respective experimental set ups in the field and were really fascinated when they came face to face with the real time ionosphere as observed in the Ionosonde ionograms. The laboratory sessions on the second day were centred on the geomagnetic observatories, importance of geomagnetic data and basics of geomagnetism. Working principle of various instruments used for magnetic measurements were explained, e.g. Digital Fluxgate Magnetometers (DFM), Declination Inclination Magnetometer (DIM) etc. Also the methodology of observations was demonstrated by using few of these instruments. In addition, they came to know about the study of thunderstorms through Transient Luminous Events (TLE) experiments. On the third day, the students of IMPRESS-2014 visited the palaeomagnetic laboratory at KSKGL, Allahabad and had hands-on-experience on instruments used for rock-magnetic and palaeomagnetic research work viz. SQUID, JR-6, and Molspin spinner magnetometer; Molspin AF and MMTD80 thermal demagnetizer; Bartington MS-2B susceptibility meter and

Students visiting the palaeomagnetic laboratory at KSKGRL, Allahabad during IMPRESS-2014

Participants of IMPRESS-2014 along with the Director and faculties at KSKGRL, Allahabad

Kly-4s kappabridge; MMPM9 and Molspin pulse magnetizer; MicroMag AGM; rock coring machine. Also they were acquainted with different petrology and GPS based techniques. On the last day, before the concluding session, all students were briefed about the current research going on in IIG.

The IMPRESS gives the students a unique opportunity as it covers a range of scientific concepts starting from the core of the earth to the sun. During the three day meet, the participants were exposed to the state-of-art observational tools which would provide them glimpses of inner-working of the Earth's interior and enable them grasp the processes in the atmosphere which are so vital for the survival of living beings on this planet.

The concluding session was very informal and was highly interactive for the students. Feed-backs were taken from each participant to know about their response and experience during IMPRESS-2014. The responses of the students were really overwhelming and most of them suggested the duration to be increased to at least 5 days. The one and only motto of this programme was to motivate the young students towards research in general but particularly in Earth and Space Sciences. The IMPRESS-2014 had a stimulating impact on the minds of young post graduates. The success of the IMPRESS was possible because of the young and dynamic research scholars who worked tirelessly. IIG will continue to conduct the IMPRESS programme every year in any one of its regional centres or observatories with the hope that brilliant students can be drawn towards research and make it as a career to boost the scientific capabilities.

IIG STAFF WELFARE AND RECREATION CLUB

IIG Staff Welfare and Recreation Club started the year 2013-14 by organizing IIG's 42nd Annual Day celebration on April 1, 2013. The festivities spanned over two sessions. The morning session commenced with the Director presenting a brief account of the Institute's activities and achievements. Prof. S. Ananthakrishnan, former Director, Giant Metrewave Radio Telescope, TIFR, Pune, was the Chief Guest. He delivered the Foundation Day lecture on "Very Long Baseline Interferometry versus Synthetic Aperture Radar". Employees contributing a major portion of their official work in Hindi were felicitated.

The second session comprised entertainment involving individual and group performances by Staff and their family members. Celebrations for the day concluded with the Director-in-charge handing over prizes to the winners of sporting events organized during the months from January to March 2013. The Club succeeded in making the Annual Day 2013 a successful event.

Director-in-charge Prof. S. Gurubaran felicitation the Chief Guest Prof. S. Ananthakrishnan during the Institute's 42nd Annual day celebration

Chief Guest Prof. S. Ananthakrishnan presenting the long service award to staff members

Prof. S. Ananthakrishnan delivering the Foundation Day lecture

Cultural activities being performed by students and staff members during the Institute's Annual Day celebration

Cultural activities being performed by students and staff members during the Institute's Annual Day celebration

Annual General Body Meeting of the Club was held on October 15, 2013, which transacted all the business of the agenda in a cordial manner.

The Club Library bought fiction/non-fiction books, magazines and newspapers for the benefit of the staff during the year.

The Club, on behalf of the Institute, bid farewell on superannuation to Mr. D.M.Daga, Mr. R.C.Jaisinghani and Mrs. S.N.Patil on April 30, 2013; Mr. P.G.Kadam on October 31, 2013; Mrs. P.V. Morje and Mr. Louis Carlo on November 30, 2013; Ms. R.R.Rawool on January 31, 2014; Ms. Divya Mehta and Prof. Mita Rajaram on March 31, 2014.

The club continued to provide recreational facilities to staff members during the allotted time. The co-operation and support extended by staff is gratefully acknowledged.

STAFF WELFARE MEASURES

Various staff welfare measure, such as, visit of a Resident Doctor twice a week, transport facilities from the nearest railway station, Benevolent Fund Scheme, Canteen facility etc. were provided to the staff members. Hindi and Marathi magazines and books were made available for the staff members.

STUDENTS CORNER

Ph.D. Degree Awarded/Submitted

1. Chinmay Kumar Nayak

Submitted his thesis on April 9, 2013 and was provisionally awarded Ph.D. degree on February 25, 2014 by the University of Mumbai on the topic *"Study of the Variability of Equatorial and low latitude ionosphere in the Indian region using radio waves"* under the supervision of Prof. Satyavir Singh.

2. Mahesh Srivastava

Submitted his thesis in January, 2013 and was provisionally awarded Ph.D. degree in September, 2013 by the University of Mumbai on the topic *"Estimation of strain distribution of the seismogenic regions of India, from GPS measurements: Numerical modeling, interpretations and implications"* under the supervision of Prof. C.D. Reddy.

3. Ajeet K. Maurya

Submitted his thesis on March 11, 2013 and was provisionally awarded Ph.D. degree on October 11, 2013 by the University of Mumbai on the topic *"ELF/VLF wave studied of Ionosphere and Magnetosphere electromagnetic phenomenon in low latitude region"* under the supervision of Dr. Rajesh Singh.

4. Md. Arif

Submitted his thesis on April 17, 2013 and was provisionally awarded Ph.D. degree on March 6, 2014 by the University of Mumbai on the topic *"Rock Magnetism and Palaeomagnetism of Meteorite Impact Craters in India"* under the supervision of Prof. N. Basavaiah.

5. B. Remya

Submitted her thesis on August 12, 2013 to the University of Mumbai on the topic *"Beam and temperature anisotropy driven plasma instabilities in the solar wind and the Earth's magnetosphere system"* under the supervision of Prof. R. V. Reddy.

6. Prasanta Kumar Das

Submitted his thesis on February 10, 2014 to the University of Mumbai on the topic *"Magnetic investigations of urban pollution at Mumbai and Nashik, Maharashtra, India: Mineral magnetic method as a pollution proxy"* under the supervision of Prof. N. Basavaiah.

7. S. Devanadhan

Submitted his thesis on December 31, 2013 to the University of Mumbai on the topic *"Study of some Linear and Nonlinear Phenomena in Space Plasmas"* under the supervision of Prof. Satyavir Singh.

Awards/ Recognition

1. B. Remya

Received the **Student's Best Presentation Award** in Indian Geophysical Union-2014 meeting held at Hyderabad, during January 8-12, 2014.

2. Ajeet K. Maurya

Received **Honorable mention** for paper presented in Regional Conference in Radio Science-2014 held at SIT, Pune during January 2-5, 2014 in Indian URSI Young Scientists Award competition.

3. Sneha Gokani

(a) Received **PSSI Best Oral Presentation Award** in 28th National symposium on Plasma Science and Technology, Plasma-2013, held at KIIT, Bhubaneswar, India during December 3–6, 2013,

For all Pictures: Scientific discussions of Students and staff members from the institute with international scientists in AOGS-2013 at Brisbane, held during June 24-28, 2013 at Brisbane, Australia

(b) Received **Third prize** in **URSI Students paper Competition** in Regional Conference on Radio Sciences held at SIT, Pune during January 2-5, 2014

4. Neethal Thomas

Received **Best Poster Award** under the section PS3 (Sun-Earth interactive phenomena, magnetosphere, ionosphere, thermosphere and middle atmosphere and their interactions) in 18th National Space Science Symposium (**NSSS - 2014),** held on January 29 – February 1, 2014 at Dibrigarh University, Assam.

Post-doctoral Fellowship

1. Ajeet K. Maurya

Awarded "Research Associate Fellowship" of Council of Scientific and Industrial Research (CSIR), India during April 2014, fellowship will commence from October 1, 2014.

2. Mahesh Srivastava

Selected as Post Doctoral Fellow at National Research Center for Integrated Natural Disaster Management (CIGIDEN), Universidad Católica del Norte, Chile.

Participation in conferences/symposia

National

Regional Conference of Radio Science (RCRS), January 2-5, 2014, SIT, Pune

Following students participated:

Chinmaya K. Nayak, B. Remya, Ajit K. Maurya, Virendra Yadav, Sneha Gokani, K. Venkatesham and R. Selvakumaran,

50th Annual Convention, Indian Geophysical Union (IGU-2014), January 8-12, 2014, Hyderabad, India

Following students participated:

Md. Arif and B. Remya

18th National Space Science Symposium (NSSS - 2014), held on January 29- February 1, 2014 at Dibrugarh University, Assam

Following students participated:

Ajeet K. Maurya, S. Devanandhan, Neethal Thomas, Sandeep Kumar, Md. Kutty, Sneha Gokani, Sreeba Sreekumar, Sukanta Sau, N. Jeni Victor, S. Manu, K. Venkatesham and R. Selvakumaran

28th National Symposium on Plasma Science and Technology Plasma-2013, during December 3-6, 2013, at KIIT, Bhubaneswar, Orissa, India

Following students participated:

Ajeet K. Maurya, Sneha Gokani, K. Venkatesham and R. Selvakumaran

International

8th European Workshop on Collisionless Shocks, Paris, France, June 4-7, 2013

B. Remya participated and presented a paper.

Asia Oceania Geosciences Society (AOGS-2013), held on June 24-28, 2013 at Brisbane, Australia

Following students participated:

B. Jayashree, S. Manu, R. Selvakumaran, Sandeep Kumar,

XIIth scientific assembly of International Association of Geomagnetism and Aeronomy (IAGA-2013), August 26-31, 2013 at Merida, Mexico

Following students participated:

C.K. Nayak, B. Remya, R. Selvakumaran,

Participation in schools/ training

R.Selvakumaran participated in International Association of Geomagnetism and Aeronomy **(IAGA)** first Summer school held at Mérida, Yucatan, Mexico, from August 20-24, 2013.

Sandeep Sathian participated in "Winter School in Geomathematics", sponsored by Science and Engineering Research Board, DST, Govt. of India, organized at Wadia Institute of Himalayan Geology, Dehradun during December 16-30, 2013.

B. Jayashree participated in a workshop on Formulation of research and development initiatives for women scientists and technologists during February 5-7, 2014, Hyderabad.

Miscellaneous

All Ph.D. students and Research Associates from IIG, Mumbai and KSKGRL, Allahabad participated in IMPRESS-2014 during March 19-21, 2014 at Dr. K.S. Krishnan Geomagnetic Research Laboratory (KSKGRL), Allahabad.

Manu S. was actively involved in successful launch of the Balloon Experiment on the Electrodynamics of Near Space (BEENS) on December 14, 2013 at National Balloon Facility, TIFR, Hyderabad.

CORPORATE SOCIAL RESPONSIBILITIES

RIGHT TO INFORMATION ACT 2005

The Institute has operationalised the Act and the following authorities have been appointed under the act:

Chief Public Information Officer:
Dr. R.V. Reddy, Professor-F
Indian Institute of Geomagnetism
Kalamboli Highway, New Panvel

Appellate Authority :
Dr. S. Gurubaran, Professor-F
Indian Institute of Geomagnetism
Kalamboli Highway, New Panvel

PUBLIC GRIEVANCES REDRESSAL MECHANISM

The General Public having any grievance can approach **Prof. R.V. Reddy** at the Institute. Director shall be the Appellate Authority.

CITIZEN CHARTER

Information/suggestion on the functioning of the Institute can be obtained/given by the public. The following nodal officers have been nominated for this purpose :

Dr. R.V. Reddy, Professor-F
Indian Institute of Geomagnetism
Kalamboli Highway, New Panvel

Head,
E.G.R.L.,
Vittalapuram, Tirunelveli, Tamil Nadu

Head,
Dr. KSKGRL,
Jhusi, Allahabad

RESERVATION POLICY

The Institute has been implementing the reservation policy of the Govt. of India from time to time.

STAFF PROFILE

Academic	**41
	*40
Technical	**84
	*80
Administration	**41
	*33
Maintenance	**37
	*13

**Sanctioned staff strength

*Staff strength as on March 31, 2014

ACTION TAKEN NOTE ON AUDITORS REPORT

No serious adverse comments have been received. However, replies to some of the observations made are appended with the Audit Report of the Institute for the year 2013-14.

MOBILIZATION OF RESOURCES

The Institute has been constantly making endeavours to mobilize resources by extending its scientific and technical expertise to organizations like NHPC Ltd., ONGC and by selling magnetic data to outside organizations. During the year 2013-2014, the Institute received funds for carrying out the objectives of various sponsored projects. The gains from sponsored projects in terms of academic activity are immense.

No patent was filed nor technology transferred for commercial use.

In service of the nation…..

The vision of Indian Institute of Geomagnetism, a premier research organization of the country, is to enable India become a global knowledge centre by promoting, guiding and conducting basic and applied research in Geomagnetism and Allied fields. Research activities in this area have greatly benefited from the unprecedented growth in recent decades, as sophisticated instruments capable of monitoring changes within the Earth and its exterior through a variety of ground-, marine-, balloon-, aero- and satellite-based platforms became available. The Institute's mandate is also to maintain and modernize the twelve Magnetic Observatory Network; establish new observatories and publish high quality data as Indian Magnetic data volumes. The magnetic records from these observatories serve as useful tools for the study of ionospheric and magnetospheric current systems under varied solar-interplanetary and geomagnetic activity conditions with a bearing on the health of satellite navigation systems, power grids to climate change. **WDC-Geomagnetism, Mumbai** is now a member of the new global **ICSU World Data System**. As per new ICSU WDS norms, modernization of the centre's infrastructure and upgradation of WDC database have been undertaken for additional online data services and Quick-look plots of real time data from existing Magnetic Observatories.

The Institute continues to operate magnetometers, various atmospheric electricity sensors, GPS receivers and AWS at the Indian Antarctic stations, Maitri and Bharati, to study the Geospace environment in this region.

To give an insight into the motion and related mass balance and future behavior of the Vestre Broggerbreen Glacier, Svalbard, Arctic, first GPS campaign was carried out with the installation of 15 campaign sites on the glacier.

The Institute has been constantly making endeavours to mobilize its resources by extending its scientific and technical expertise, as a part of Technology Development program, Consultancies and Services. IIG partakes in national capacity building by imparting training/courses to Society of Petroleum Geophysicists to look into the magnetic / electromagnetic methods of resource prospecting. Researchers of the Institute analyzed geopotential data for ONGC complementary to the interpreted seismic sections. Magnetotelluric studies were carried out in Cambay basin for the ONGC. These studies identified the Mesozoic sediments, which are potential zones for oil and gas. Broad-band and audio magnetotelluric survey were also carried out in Chumathang and Puga geothermal regions; and in Pasighat-Dambuk region of Arunachal Pradesh as a part of consultancy project from DRDO and NHPC Ltd. respectively. These research studies provide an opportunity to evaluate the potential of several types of energy resources in the country.

Groundwater being a natural and renewable resource plays a vital role in the socio-economic development of any region. The hard rock terrain of Deccan Volcanic Province (DVP) in Maharashtra is facing a major problem in terms of depletion of groundwater due to various reasons such as sporadic spatial and temporal distribution of precipitation. Thus, for the benefit of the society, it is pertinent to identify additional sources of groundwater for exploitation all over the Deccan Trap covered region. As an example, Electrical Resistivity Tomography investigations were carried out at the Vanavasi Kalyan Ashram sponsored Vijaya Gopal Gandhi Primary and Secondary Ashramshala, Utekhol in Mangaon, Maharashtra. This school caters to about 450 tribal students staying on a water starved campus. Our researchers have helped to mitigate this long-standing problem. The Institute aims to address greater societal causes by exploring more such areas which are affected by depleting water table and deplorable water quality.

In-situ probing of stratospheric electric fields from a balloon platform was attempted for the first time during an experiment conducted from the TIFR's high altitude balloon facility, Hyderabad, on December 14, 2013. A useful outcome of this exercise has been detecting the presence of 10-15 mV/m horizontal electric fields which appears to be driven by atmospheric gravity waves of local origin. The success of this experiment on balloon platform would hopefully facilitate the way for launching such instruments on satellites.

Concerns about global climate change have highlighted the gaps in the Indian Summer Monsoon (ISM) and the absence of long term palaeo-climate data from the central Indian core monsoon zone (CMZ). Researchers at IIG are engaged in the multi-proxy reconstruction of Holocene palaeo-climate from a 10 m long sediment core raised

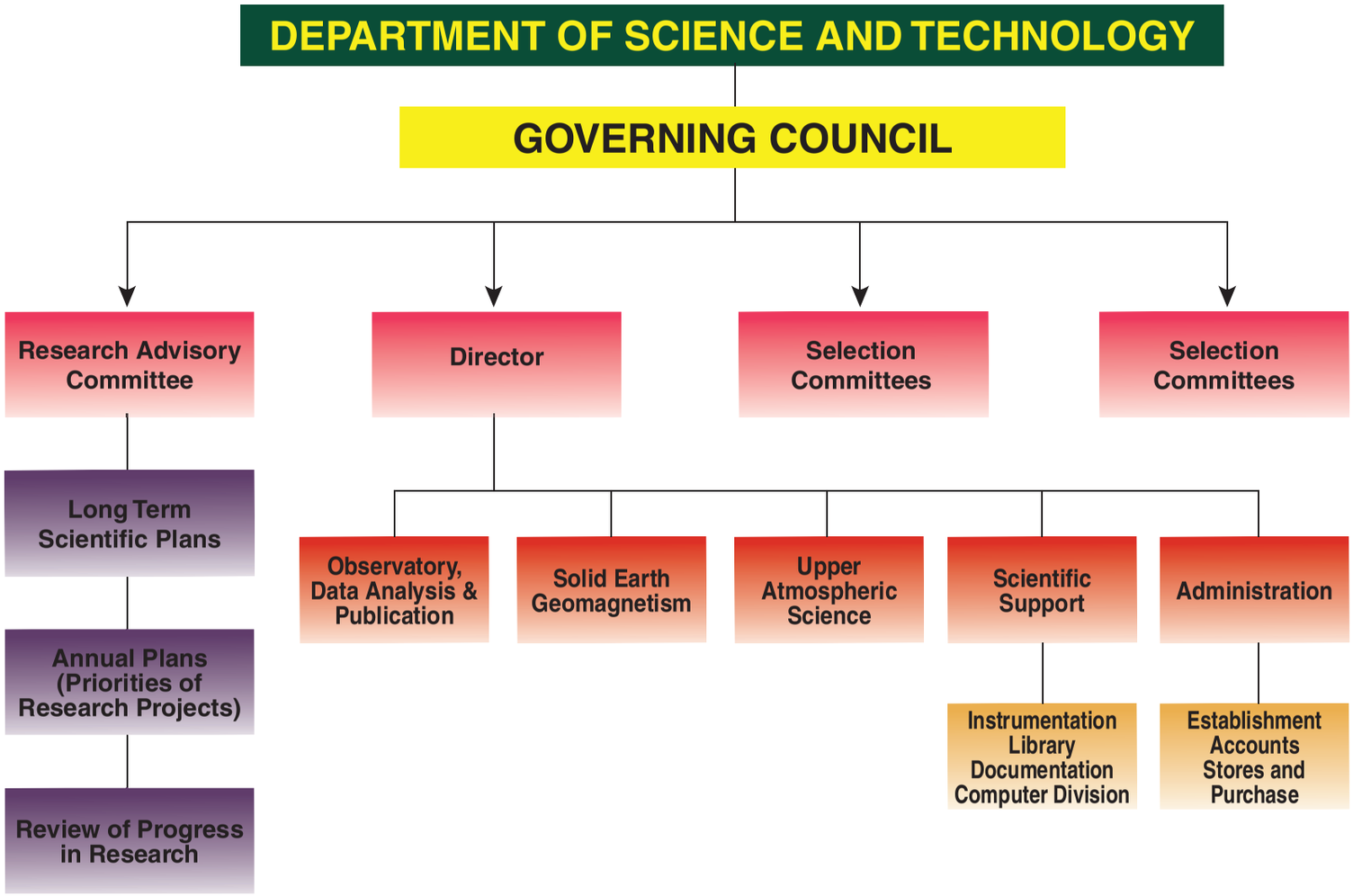
from the Lonar Lake in central India. The analysis showed two prolonged droughts (PD) between 4.6–3.9 and 2–0.6 calibrated ka coincident with intervals of higher solar irradiance, demonstrating: (i) the regional warming in the Indo-Pacific Warm Pool (IPWP) played an important role in causing ISM PD; (ii) the long term influence of conditions like El Niño-Southern Oscillation (ENSO); and (iii) the first settlements in central India coincided with the onset of the first PD and agricultural populations flourished between the two PD, highlighting major environmental factors affecting human settlements.

Capacity building for scientific research is a major mission of the Institute. To attract, motivate and train young talent to undertake research in geomagnetism and allied areas, several new initiatives have been designed, such as the "IMPRESS" program for post-graduate students from Indian universities and "Dr. Nanabhai Moos" Post-Doctoral Fellowship to research scientists.

The Institute has more than 15 collaborations with National and International organizations. In the service of our nation, consultancy was extended to organizations such as Survey of India, CSIR-National Geophysical Research Institute, the Indian Navy, Indian Coast Guard, Naval Air Stations, Indian Naval Ships, Pawan Hans Helicopter Ltd. and other scientific, defence and research organizations. In this endeavour, IIG is involved in calibration of sophisticated magnetic equipments with these organizations besides providing high resolution digital magnetic and other data.

Finally, it is the vision of IIG to make India innovative and add value to India's outstanding traditional knowledge base by acquisition and exploitation of high quality geomagnetic and geophysical data, leading to frontline research; impart training and provide scientific facilities to various national and international scientists as a measure of India's capacity building; and disseminate relevant information through public outreach programs.

ORGANIZATIONAL CHART OF THE INSTITUTE



Auditor Report
2013-14

Item-wise replies to the Auditors observations in respect of the Audit Report for the year ended 31/03/2014

B

1) No action is required.

2) The materials under the head of margin money in the form of FDR of ₹321 lakhs, have already been received and accounted in books of accounts.

3) The Movable and Immovable properties previously belonging to IMD and in occupation of the Institute: Since the land belongs to the Government of India, the matter has been taken up at highest level with parent Ministry.

4) Out of the outstanding contingent advances of ₹28,42,530/-, a sum of ₹11,96,030/- has already been adjusted. The balance of ₹16,46,500/-will be adjusted soon.

5) No action is required.

6) No action is required.

7) The physical verification of fixed assets was carried out by the Institute. Loss of value due to depreciation etc. has also been worked out and proposal for write off of the loss is being submitted. On completion of this process, reconciliation of fixed assets with books will be carried out.

8) No action is required.

9) The Grant-in-aid received from the government and utilized for acquisition of immovable properties has been taken in the Books of Accounts. For some of the buildings, constructed out of these funds, the finalization of accounts have not been received. After completion of these processes, the value will be transferred to the Trust Fund.

10) Proposal for write off of an amount of ₹6,03,900/- have been sent to Department of Science & Technology for approval. The necessity for procurement of the Laboratory Equipment will be examined and based on this, decision will be taken as to whether provision have to be made or not.

11) Interest earned on advances to staff is taken as receipt of the Institute.

12) The retirement fund is being managed by the Institute in a separate bank account and it is kept separately from business of IIG. The Governing Council of IIG will be reviewing the investment portfolio pertaining to pension fund and it is expected that a separate scheme for managing the Pension Fund will be formulated shortly.

Narendra Samar
B.Com., F.C.A.

NARENDRA SAMAR & CO.
Chartered Accountants

AUDITORS' REPORT
TRUST REGISTRATION NO. AF/2375
SOCIETY REGISTRATION NO. 91 / 71. GBBS

To,
The Governing Council,

We have audited the attached Balance Sheet of **Indian Institute of Geomagnetism** as at 31st March 2014, and also the Income and Expenditure Account of the Institute for the year ended on that date, annexed thereto. These financial statements are the responsibility of the management of the Institute. Our responsibility is to express an opinion on these financial statements based on our audit and report that –

1. We conducted our audit in accordance with auditing standards generally accepted in India. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statement. An audit also includes assessing the accounting principles used and significant estimates made by the management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.
2. further to our comments referred to in paragraph 1 above, we state that –

a. We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purpose of our audit.
b. In our opinion, proper books of account, as required by law have been kept by the Institute, so far as it appears from our examination of the books of accounts.
c. The Balance Sheet and the Income and Expenditure account dealt with by this report are in agreement with the Books of Accounts.
d. In our opinion, and to the best of our information and according to the explanations given to us, the said accounts, read together with the notes on Accounts ***subject to Note No.3 for non transfer of property, Note No.7 for accounting of government grants related to fixed assets, Note No.8 for non-provision of doubtful advances,*** gives a true and fair view.

i) In the case of the Balance Sheet of the state of affairs of the Institute as at 31st March 2014 and
ii) In the case of the Income & Expenditure Account, of the Surplus for the financial year ended 31st March 2014.

For, Narendra Samar & Co.
Chartered Accountants
Firm No. 126415W

Narendra Samar
(Partner)
Membership No.119521

Place: Thane
Date: 01/08/2014

H.O.: 5, Ground Floor, Amfotech Park, Opp. MIDC Office, Road No.16, Wagle Estate, Thane (W) - 400604.
022 2582 7712 / 093 2430 9929 n.samar2005@gmail.com cansamarandco@gmail.com

Branch Off.: 115, Shastri Nagar, Chittorgarh (Rajasthan) - 312001.

FORM OF FINANCIAL STATEMENTS (NON – PROFIT ORGANISATIONS)

Name of Entity : Indian Institute of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

BALANCE SHEET AS AT 31ST MARCH 2014

(Amount – Rs.)

CAPITAL FUND AND LIABILITIES	Schedule	Current Year	Previous Year
CAPITAL FUND	1	697311954	727701473
RESERVES AND SURPLUS	2	0	0
EARMARKED / ENDOWMENT FUNDS	3	0	0
SECURED LOANS AND BORROWINGS	4	0	0
UNSECURED LOANS AND BORROWINGS	5	0	0
DEFERRED CREDIT LIABILITIES	6	0	0
CURRENT LIABILITIES AND PROVISIONS	7	13077916	21254067
TOTAL		**710389870**	**748955540**
ASSETS			
FIXED ASSETS	8	678919541	703035733
INVESTMENTS – FROM EARMARKED / ENDOWMENT FUNDS	9	0	0
INVESTMENTS – OTHERS	10	2750	25002750
CURRENT ASSETS, LOANS, ADVANCES ETC.	11	31467579	20917057
MISCELLANEOUS EXPENDITURE (TO THE EXTENT NOT WRITTEN OFF OR ADJUSTED)			
TOTAL		**710389870**	**748955540**

As per our Report of even dated As per our Report of even dated

For M/s. NARENDRA SAMAR & CO.
Chartered Accountants
Firm No. 126415W

Narendra Samar
Membership No. : 119521
Partner

Place : Thane
Dated : 01/08/2014

The above Balance Sheet to the best of my knowledge and belief contains a true and fair account of the funds and liabilities and property assets of the Trust.

For INDIAN INSTITUTE OF GEOMAGNETISM

K. Kumar
ACCOUNTS OFFICER

D. S. Ramesh
THE DIRECTOR FOR TRUSTEE

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)
Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

INCOME AND EXPENDITURE ACCOUNT FOR THE PERIOD / YEAR ENDED 31ST MARCH 2014

(Amount – Rs.)

INCOME	Schedule	Current Year	Previous Year
Income from Sales / Services	12	0	0
Grants / Subsidies	13	251580000	282900000
Fees / Subscriptions	14	223693	209349
Income from Investments (Income on Invest. from earmarked/endow. Funds transferred to Funds)	15	0	0
Income from Royalty, Publication etc.	16	0	0
Interest Earned	17	8751286	6291278
Other Income / Profit on sale of assets	18	1700025	1545772
Increase / (decrease) in stock of Finished goods and works-in-progress	19	0	0
TOTAL (A)		**262255004**	**290946399**

K. Kumar D. S. Ramesh

Partner

Cont...II

EXPENDITURE	Schedule	Current Year	Previous Year
Establishment Expenses	20	146560338	136691486
Other Administrative Expenses etc.	21	84459340	89821554
Expenditure on Grants, Subsidies etc.	22	490000	200000
Interest	23	0	0
Loss on sale of Asset		25292	81666
Depreciation	8	61109552	70235030
TOTAL (B)		**292644522**	**297029736**
Balance being excess of Income over Expenditure (A-B) Transfer to Special Reserve (Specify each)		-30389518	-6083337
Transfer to / from Income and Expenditure A/c		0	0
Balance being deficit carried to Corpus / Capital Fund		**-30389518**	**-6083337**

As per our Report of even dated 2014

For M/s. NARENDRA SAMAR & CO.
Chartered Accountants
Firm No. 126415W

Narendra Samar & Co. Partner Chartered Accountants

Narendra Samar
Membership No. : 119521
Partner

Place : Thane
Dated : 01/08/2014

The above Income and Expenditure A/c to the best of my knowledge and belief contains a true and fair account of the Income and Expenditure of the Trust

For INDIAN INSTITUTE OF GEOMAGNETISM

K. Kumar
ACCOUNTS OFFICER

D.S. Ramesh
THE DIRECTOR FOR TRUSTEE

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)
Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.
SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 1 : CAPITAL FUND	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
Balance as at the beginning of the year	727701472	733784809
Add : Contributions towards capital Fund		0
Add : Balance of net income transferred from the Income and Expenditure Account	-30389518	-6083337
BALANCE AS AT THE END OF THE YEAR	**697311954**	**727701472**

K. Kumar D.S. Ramesh

Partner

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)
Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.
SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 2 : RESERVES AND SURPLUS	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

SCHEDULE 3 : EARMARKED/ENDOWMENT FUNDS	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

SCHEDULE 4 : SECURED LOANS AND BORROWINGS	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

SCHEDULE 5 : UNSECURED LOANS AND BORROWINGS	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

SCHEDULE 6 : DEFERRED CREDIT LIABILITIES	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

SHEDULE 9 : INVESTMENTS FROM FARMARKED/ENDOWMENT FUNDS	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

K. Kumar D. S. Ramesh

Partner

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)

Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 7 – CURRENT LIABILITIES AND PROVISIONS			Current Year	Previous Year
A. CURRENT LIABILITIES				
1	Acceptances		0	0
2	Sundry Creditors:			
	a)	For Goods	428597	325926
	b)	Others	1007022	201125
3	Securiy Depsoit Payable		2649450	1672721
4	Interest accrued but not due on:			
	a)	Secured Loans/borrowings	0	0
	b)	Unsecured Loans/borrowings	0	0
5	Statutory Liabilities:			
	a)	Overdue	0	0
	b)	Others	0	0
6	Other current Liabilities (other Projects)		305116	276491
TOTAL (A)			4390185	2476263
B. PROVISIONS				
1	Loss on interest for GPF		0	0
2	Gratuity		2407845	6317214
3	Superannuation / Pension		1952402	4213158
4	Accumulated Leave Encashment		1660080	3834723
5	Trade Warranties/Claims		0	0
6	Others current Liabilities (for expenses on telephone, electricity, water charges etc.)		2667404	4412709
TOTAL (B)			8687731	18777804
TOTAL (A + B)			**13077916**	**21254067**

K. Kumar D. S. Ramesh

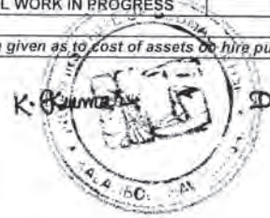
Narendra Samar & Co. Partner Chartered Accountants

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)
Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.
SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 8 : FIXED ASSETS	GROSS BLOCK				DEPRECIATION					NET BLOCK	
DESCRIPTION	Cost / valuation as at beginning of the year 01/04/2013	Additions during the year	Deductions during the year	Cost/valuation at the year-end 31/03/2014	As at the beginning of the year 01/04/2013	On additions during the year	For the year 2013-14	On deductions during the year	Total up to the year – end 31/03/2014	As at the current year-end 31/03/2014	As at the previous year-end 31/03/2013
A. FIXED ASSETS											
1 LAND :											
a) Freehold	3493366	0	0	3493366	0	0	0	0	0	3493366	3493366
b) Leasehold	56466353	0	0	56466353	20931198	0	789670	0	21720868	34745485	35535155
2 BUILDINGS:											
a) On freehold Land	209159311	1232610	0	210391921	68669636	23470	7024483.00	0	75717589	134674332	140489675
b) On Leasehold Land :	246283121	2226368	0	248509489	53198801	39930	9654217	0	62892948	185616541	193084320
d) Ownership Flats/Premises	0		0	0	0		0	0	0	0	0
e) Superstructures on Land Not belonging to the entity	0		0	0	0		0	0	0	0	0
3 LABORATORY EQUIPMENT	419249669	20530092	0	439779761	213206319	1145576	30906503	0	245258398	194521363	206043350
4 MOTOR CAR VEHICLE	3332404	1070479	0	4402883	2865970	13638	89965	0	2949573	1453310	466434
5 FURNITURE, FIXTURES	23318956	625301	0	23944257	13905030	95700	941393	0	14942123	9002134	9413926
6 OFFICE EQUIPMENT	24908164	823692	123909	25607947	13713713	52996	1667966	0	15434675	10173272	11100591
7 COMPUTER & SOFTWARE	99259922	6788111	924827	105123206	89191369	1561713	5529976	0	96283058	8840148	9216032
9 ELECTRIC INSTALLATIONS	3517974	0	0	3517974	2864052	0	98088	0	2962140	555834	653922
10 LIBRARY BOOKS	34535132	1494268	0	36029400	34535132	0	1494268	0	36029400	0	0
TOTAL OF CURRENT YEAR	1123524372	34790921	1048736	1157266557	513081220	2933023	58176529	0	574190772	583075785	609496771
PREVIOUS YEAR	256112532	39438530	202012100	93538962						0	0
B. CAPITAL WORK IN PROGRESS	93538962	26760007	24455213	95843756						95843756	93538962
TOTAL										678919541	703035733

(Note to be given as to cost of assets on hire purchase basis included above)



FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)

Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2014

SHEDULE 10 – INVESTMENTS – OTHERS		Current Year	Previous Year
1)	In Government Securities	0	0
2)	Other approved Securities	0	0
3)	Shares (no. of shares of Rs.....)	2750	2750
4)	Debentures and Bonds	0	0
5)	Subsidiaries and Joint Ventures	0	0
6)	SDR with Bank	0	25000000
	TOTAL	**2750**	**25002750**

K. Kumar D. S. Ramesh

Narendra Samar & Co. Partner Chartered Accountants

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)

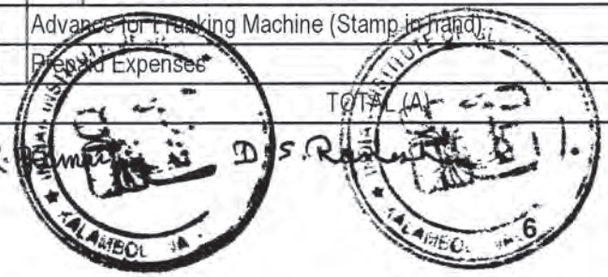
Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 11 : CURRENT ASSETS, LOANS, ADVANCES ETC.			Current Year	Previous Year
A. CURRENT ASSESTS				
1)	Inventories			
	a)	Stores and spares (closing bal. in stores)	539748	569474
	b)	Loose Tools		0
	c)	Stock-in-Trade		0
		Finished Goods		0
		Work-in-Progress		0
		Raw Materials		0
2)	Sundry Debtors:			0
	a)	Debts Outstanding for a period exceeding six months		0
	b)	Others		0
3)	Cash Balances in hand (including cheques / drafts and imprest)		39017	14017
	Head Office	---		
	Sub Office	9017.00		
	Cash for emergency	25000.00		
	Petty Cash	5000.00		
4)	Bank Balances:			
	a)	With Scheduled Banks:		
		-- On Current Accounts – Bank of India, Panvel	3682106	6376247
		-- Union Bank of India, Panvel	216044	2705936
		-- Bank of India, Allhabad	10000	10000
		-- Bank of India, Tirunelvelli	204334	309885
		-- Bank of India, LC A/c. 365	16865660	1106936
5)	Advance for Franking Machine (Stamp in Hand)		38095	2886
6)	Prepaid Expenses		62110	41248
		TOTAL (A)	21657114	11136629

K. [illegible] D. S. Rao



FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)

Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 11 : CURRENT ASSETS, LOANS, ADVANCES ETC.(CONTD.)			Current Year	Previous Year
B. LOANS, ADVANCES AND OTHER ASSETS				
1)	Loans			
	a)	Staff	4492821	5815676
	b)	Other entities engaged in activities / objectives similar to that of the entity		0
	c)	Other (specify)- Contingent Advances	2842530	1820474
2)	Advances and other amounts recoverable in cash or in kind for value to be			
	a)	On Capital A/c	0	0
	b)	Pre-payments	0	0
	c)	Others	2405528	1656869
3)	Income Accrued			
	a)	On Investments from earmarked / endowment funds	0	0
	b)	On Investments – Others Accrued interest of SDR on LC	69586	487409
	c)	On investment in SDR	0	0
	d)	Others (includes income due unrealized Rs.....)	0	0
4)	Claims Receivable		0	0
		TOTAL (B)	9810465	9780428
		TOTAL (A + B)	**31467579**	**20917057**

K. Kumar D. S. Rawat

Narendra Samar & Co. Chartered Accountants Partner

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)

Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 12 : INCOME FROM SALES / SERVICES	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

SCHEDULE 15 : INCOME FROM INVESTMENTS (Income on Invest. From Earmarked/Endowment Funds transferred to Funds)	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

SCHEDULE 16 : INCOME FROM ROYALTY, PUBLICATION ETC. (Income on Invest. From Earmarked/Endowment Funds transferred to Funds)	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

SCHEDULE 19 : INCREASE/(DECREASE) IN STOCK OF FINISHED GOODS & WORK IN PROGRESS	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

SCHEDULE 23 : INTEREST	Current Year as on 31/03/2014	Previous Year as on 31/03/2013
	NIL	NIL
TOTAL	NIL	NIL

K. Kumar D.S. Rajput

Narendra Samar & Co. Partner Chartered Accountants

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)
Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.
SCHEDULE FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 13 : GRANTS/SUBSIDIES (Irrevocable Grants & Subsidies Received)		Current Year	Previous Year
1)	Central Government - Received from Department of Science & Technology	251580000	282900000
2)	State Government	0	0
3)	Government Agencies	0	0
4)	Institutions/welfare Bodies	0	0
5)	International Organizations	0	0
6)	Others (Specify)	0	0
		251580000	**282900000**

K. Kumar D. S. Ramesh

Narendra Sarda & Co. Partner Chartered Accountants

FORM OF FINANCIAL STATEMENTS (NON-PROFT ORGANISATIONS)

Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 14 : FEES / SUBSCRIPTION			Current Year	Previous Year
1)	Entrance Fees		0	0
2)	Annual Fees / Subscriptions		0	0
3)	Seminar / Program Fees		0	0
4)	Consultancy Fees		0	0
5)	Others (Specify)		0	0
	a)	CGHS contribution	0	0
	b)	Service charges – IIG	20510	24730
	c)	License fees – IIG	203183	184619
TOTAL			**223693**	**209349**

Note : Accounting Policies towards each item are to be disclosed

K. Kumar D. S. Ramesh

Narendra Sundar & Co. Partner Chartered Accountants

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)

Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2014

SCHEDULE 17 : INTEREST EARNED			Current Year	Previous Year
1)	On Term Deposits:			
	a)	With Scheduled Banks	0	0
	b)	With Scheduled Banks (Bank of India) - From investment in SDR */LC	8157604	5723601
	c)	With Institutions	0	0
2)	On Savings Accounts		0	0
	a)	With Scheduled Banks	0	0
	b)	With Non-Scheduled Banks	0	0
	c)	Post office Savings A/cs	0	0
	d)	Others	0	0
3)	On Loans		0	0
	a)	Staff Members	593682	567677
	b)	Others	0	0
4)	Interest on Debtors and Other Receivables		0	0
	TOTAL		**8751286**	**6291278**

Note : Tax deducted at source to be indicated

K. Kumar D.S. Ramesh

Partner

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)

Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 18 : OTHER INCOME			Current Year	Previous Year
1)	Profit on Sale / disposal of Assets:			
	a)	**Owned assets**	30735	46302
	b)	Assets acquired out of grants, or received free of cost		
2)	**Income from Project**		254001	196306
3)	**Sale of data & PPM**		0	110000
4)	Miscellaneous Income			
	a)	**Income from hostel / Guest house**	797127	697339
	b)	**Miscellaneous receipt**	618162	495825
TOTAL			**1700025**	**1545772**

K. Gkumar D.S.R

Surendra Sarnaik & Co. Partner Chartered Accountants

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)

Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 20 : ESTTABLISHMENT EXPENSES		Current Year	Previous Year
a)	Salaries	117829789	107522260
b)	Allowances and Bonus	1605556	1657255
c)	Employers Contribution to CPF	26201	27684
d)	Employers contribution to Other Fund (specify) – IIG Pension A/C	11303351	8907107
e)	Employers Contribution to Benevolent Fund	25350	25635
f)	Expenses on Employees Retirement and Terminal Benefits	11820306	14748718
g)	Others (specify) (Medical Expenses)	1960371	2142658
h)	Employers contribution to Recreation Club	60325	20000
I)	Employers contribution to New Contributory Pension Fund	1929089	1640169
	TOTAL	**146560338**	**136691486**

K. Sreeram D.S. Ramesh

Virendra Sarraf & Co. Partner Chartered Accountants

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)

Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 21 : OTHER ADMINISTRATIVE EXPENSES		Current Year	Previous Year
1	Advertisement and Publicity	1738854	2784556
2	Audit Fees	50562	44944
3	Bank charges	8271	78238
4	Binding charges	58580	28495
5	Canteen Subsidy	659391	0
6	Conservation of old volumes	4533630	2630850
7	Design & Fabrication	149494	0
8	Electricity and power / Charges	11702412	11794878
9	Entertainment / Hospitality	380981	65784
10	Garden Expenses	638677	1773181
11	Guest house maintenance / ChargesGueste house items	889712	193337
12	Hindi expenses / awards	75616	111175
13	House keeping expenses	2440868	2237941
14	IIG Annual Day A/c	126290	65954
15	Insurance	87085	185220
16	Journals	4001726	3474949
17	Liveries	35359	8062
18	Meeting expenses	504659	473832
	Balance c/f	**28082167**	**25951396**

K. Gnanam D. S. Rathore

Jitendra Sarraf & Co. Partner Chartered Accountants

SCHEDULE 21-OTHER ADMINISTRATIVE EXPENSES		Current Year	Previous Year
	Brought Forward	**28082167**	**25951396**
19	Miscellaneous expenses	626761	285926
20	MPLS-Communication Link Charges	1640340	1612460
21	NGRI A/c.	64698	0
22	Postage, Telephone and Communication Charges / Internet charges	5174483	4812958
23	Printing and Publication	578638	651492
24	Professional Charges / Consultancy Charges	884317	321345
25	Public Outreach	0	5840
26	Registration fees	146208	392829
27	Rent, Rates and Taxes	258796	509820
28	Repairs and Maintenance	7353824	13365361
29	Repairs to Building	0	9893628
30	Science week celebration / Exhibition	278834	425772
31	Scientific Expenses	1803600	752784
32	Security services	14532666	10332943
33	Staff welfare	523029	1827567
34	Stores consumed	5364088	6174568
35	Survey expenses	1050187	481099
36	Traveling and Conveyance Expenses	12696292.00	7884745
37	Vehicle maintenance	552825	624557
38	Visiting scientist / seminar / fees etc.	0	36625
39	Water charges	746570	1029032
40	Wages to Contingent Mazdoors	2101017	2448807
	TOTAL	**84459340**	**89821554**

K. S. D. S.

Narendra Samar & Co.
Partner
Chartered Accountants

FORM OF FINANCIAL STATEMENTS (NON-PROFIT ORGANISATIONS)

Name Of Entity : Indian Institute Of Geomagnetism, New Panvel, Navi Mumbai – 410 218.

SCHEDULE FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDED 31ST MARCH 2014

(Amount – Rs.)

SCHEDULE 22 : EXPENDITURE ON GRANTS,SUBSIDIES ETC	Current Year	Previous Year
a) Grants given to Institutions / Organizations	490000	200000
b) Subsidies given to Institutions / Organizations	0	0
TOTAL	**490000**	**200000**
Note : Name of the Entities, their Activities along with the amount of Grants/subsidies are to be disclosed .		

K. Kumar D. S. Ramesh

Narendra Samar & Co. Partner Chartered Accountants

SCHEDULE 7A (2)

INDIAN INSTITUTE OF GEOMAGNETISM

NEW PANVEL, NAVI MUMBAI – 410 218.

YEAR ENDING 31/03/14

LIST OF SUNDRY CREDITORS

AS ON 31/03/13 Rs Ps			PARTICULARS	AS ON 31/03/14 Rs Ps
	A)	SECURITY DEPOSIT PAYABLE		
1447565.00		1	Deposit from others (Security)	2246064.00
225156.00		2	Earnest Money Deposit	403386.00
1672721.00			**Sub-Total**	**2649450.00**
	B)	OTHERS		
40450.00		1	M/s. Jain M. & Company	18203.00
0.00		2	M/s. Narendra Samar & Co.	27303.00
57282.00		3	Mr. R.R. Tambe (Bonus & Grauity)	57282.00
550.00		4	Mr.V.J.Jacab	0.00
180.00		5	Mr.S. Maiti	0.00
151.00		6	Mr. K. Jeeva	0.00
750.00		7	Mr. M. Doiphode	0.00
294.00		8	Mr. Manu S.	0.00
29.00		9	Mr. Sachin Labde	0.00
1120.00		10	Mr. Sandeep Kumar	0.00
1120.00		11	Mr. Selvakumaran	0.00
80836.00		12	TDS Payable	25875.00
1500.00		13	GPF IIG	0.00
15448.00		14	IIG Contributory Pension Fund	28077.00
14.00		15	IIG Employees Benevolent Fund	0.00
1400.00		16	IIG Staff Recreation - Employees	0.00
0.00		17	Advance TA Payable	20625.00
0.00		18	Mr. Ankush Bhaskar-Air DST	78214.00
0.00		19	Mr. Ankush Bhaskar-Advance DST	15647.00
0.00		20	Mr. Anup Sinha-Advance DST	102064.00
0.00		21	Mr. Anup Sinha-Air DST	11000.00
0.00		22	Mrs. B. Jayshree Air-CSIR	67631.00
0.00		23	Ms. B. Remya Air-CSIR	187462.00
0.00		24	Mr. Devanandan Air-CSIR	73543.00
0.00		25	Mrs. Veenadhari Advance-INSA	40000.00
0.00		26	Mrs. Veenadhari Air-INSA	197575.00
0.00		27	GSLI	44643.00

K. Kumar B. S. Rawat

Narendra Samar & Co. Partner Chartered Accountants

0.00		28	M. O. Shillong	3900.00
0.00		29	M. T. Studies	362.00
0.00		30	Mr. M. Ravikumar	4057.00
0.00		31	Mr. C. D. Reddy	300.00
0.00		32	Mr. S. Mani	3259.00
201125.00			**Sub-Total**	**1007022.00**
	C)	OTHER PROJECTS		
78999.00		1	CSIR-Dr. Lakshmi's A/c	0.00
24992.00		2	INSA-G. S. Lakhina	0.00
172500.00		3	Deposit Caution Money	212500.00
0.00		4	Library Deposit	57500.00
0.00		5	NASI-G. S. Lakhina	35116.00
276491.00			**Sub-Total**	**305116.00**
	D)	FOR GOODS PURCHASES		
110437.00		1	M/s. Informatics (I) Ltd.	0.00
33188.00		2	M/s. Mahavir Sys-Power I. Ltd.	0.00
178500.00		3	M/s. Security Shoppee P. Ltd.	0.00
3801.00		4	M/s. Cosmic Enterprises	0.00
0.00		5	Advance received against write off	250886.00
0.00		6	M/s. B24E Solutions Pvt. Ltd.	43200.00
0.00		7	M/s. Delta Network	9825.00
0.00		8	M/s. Dell India Pvt. Ltd.	124686.00
325926.00			**Sub-Total**	**428597.00**
2476263.00			**TOTAL**	**4390185.00**

K. Kumar D.S. Ramesh

Narendra Samar & Co.

INDIAN INSTITUTE OF GEOMAGNETISM
NEW PANVEL, NAVI MUMBAI – 410 218.

SCHEDULE – 8A(1a)

YEAR ENDING 31/03/2014

FREEHOLD LAND

AS ON 31/03/13	PARTICULARS	AS ON 31/03/14
Rs Ps		Rs Ps
1000000.00	Land for Regional Centre at Allahabad	1000000.00
628726.00	Land for E.G.R.L., Tirunelvelli	628726.00
1864640.00	Land at Portblair	1864640.00
3493366.00	TOTAL	3493366.00

K. Kumar D. S. Ramesh

Narendra Sarraf & Co. Partner Chartered Accountants

INDIAN INSTITUTE OF GEOMAGNETISM
NEW PANVEL NAVI MUMBAI
YEAR ENDED 31-03-2013

Land And Building

Fix Assests - Immovable Property (On Freehold land)

Schedule : 8A 2(a)

Sr. No	Particulars Of Assests	Gross Block				Depreciation					Net Block	
		Cost/Value at 31-03-13	Additions during the year	Deduction during the	Cost/Value at 31-03-14	On Value 01/04/13	On addition during the year	For the year 2013-14	On deduction	Deduction during the year	Upto 31-03-14	Cost as at 31-03-13
1	Building - Capital Works	10730609.87	0.00	0.00	10730609.87	5482775.87	0.00	262392.00	0.00	5745167.87	4985442.00	5247834.00
2	Building - Belapur Quarters	19661930.13	0.00	0.00	19661930.13	11031995.13	0.00	431497.00	0.00	11463492.13	8198438.00	8629935.00
3	Building - Gulmarg	170337.27	0.00	0.00	170337.27	145802.27	0.00	1227.00	0.00	147029.27	23308.00	24535.00
4	Building - Nagpur	2052175.12	0.00	0.00	2052175.12	982172.12	0.00	53500.00	0.00	1035672.12	1016503.00	1070003.00
5	Building - Alibag Mavacs	225000.00	0.00	0.00	225000.00	156037.00	0.00	3448.00	0.00	159485.00	65515.00	68963.00
6	Building - Prefabricated Structure	155235.00	0.00	0.00	155235.00	117007.00	0.00	1911.00	0.00	118918.00	36317.00	38228.00
7	Building - Space Sci.Lab. Kolhapur	153338.00	0.00	0.00	153338.00	106339.00	0.00	2350.00	0.00	108689.00	44649.00	46999.00
8	Building - Wilton Hall	531374.51	0.00	0.00	531374.51	468428.51	0.00	3147.00	0.00	471575.51	59799.00	62946.00
9	Building - P.R. Radar Tower Kolhapur	972012.00	0.00	0.00	972012.00	527946.00	0.00	22203.00	0.00	550149.00	421863.00	444066.00
10	Building - Pondicherry	2459332.56	0.00	0.00	2459332.56	1186981.56	0.00	63618.00	0.00	1250599.56	1208733.00	1272351.00
11	Building & Quarters - EGRL	8327194.00	0.00	0.00	8327194.00	4429316.00	0.00	194894.00	0.00	4624210.00	3702984.00	3897878.00
12	Building - Alibag Quarters	7454672.00	0.00	0.00	7454672.00	4175423.00	0.00	163962.00	0.00	4339385.00	3115287.00	3279249.00
13	Building - Vishakhapatnam	907924.00	0.00	0.00	907924.00	484056.00	0.00	21193.00	0.00	505249.00	402675.00	423868.00
14	Building - Jaipur	5646974.00	0.00	0.00	5646974.00	2633578.00	0.00	150670.00	0.00	2784248.00	2862726.00	3013396.00
15	Building - GRL Allahabad	75546986.23	0.00	0.00	75546986.23	22570325.23	0.00	2648833.00	0.00	25219158.23	50327828.00	52976661.00
16	Building - Rajkot	4280804.00	0.00	0.00	4280804.00	1305416.00	0.00	148769.00	0.00	1454185.00	2826619.00	2975388.00
17	Building - Shillong (Boundry Wall)	6916354.00	0.00	0.00	6916354.00	1924763.00	0.00	249580.00	0.00	2174343.00	4742011.00	4991591.00
18	Building, Guest House, Hostel-EGRL	48252012.00	0.00	0.00	48252012.00	10046276.00	0.00	1910287.00	0.00	11956563.00	36295449.00	38205736.00
19	Building - Silchar	14715046.00	0.00	0.00	14715046.00	894998.00	0.00	691002.00	0.00	1586000.00	13129046.00	13820048.00
20	Building -- Colaba (WDC)	0.00	1232610.00	0.00	1232610.00	0.00	23470.00	0.00	0.00	23470.00	1209140.00	0.00
	TOTAL	**209159310.69**	**1232610.00**	**0.00**	**210391920.69**	**68669635.69**	**23470.00**	**7024483.00**	**0.00**	**75717588.69**	**134674332.00**	**140489675.00**

K. Kumar D.S. Ramesh

Partner

INDIAN INSTITUTE OF GEOMAGNETISM
NEW PANVEL NAVI MUMBAI
YEAR ENDED 31-03-2013

Land And Building

Fix Assests - Immovable Property (On Leasehold Land)

Schedule : 8A 2(a)

Sr. No	Particulars Of Assests	Gross Block				Depreciation					Net Block	
		Cost/Value at 31-03-13	Additions during the year	Deduction during the	Cost/Value at 31-03-14	On Value 01/04/13	On addition during the year	For the year 2013-14	On deduction	Deduction during the year	Upto 31-03-14	Cost as at 31-03-13
1	Building - Panvel	74425373.00	1989866.00	0.00	76415239.00	34208277.00	1090.00	2010855.00	0.00	36220222.00	40195017.00	40217096.00
2	Research Scholar Hostel	18362223.00	0.00	0.00	18362223.00	6228284.00	0.00	606697.00	0.00	6834981.00	11527242.00	12133939.00
3	Guest House at Panvel	35115264.00	125147.00	0.00	35240411.00	9131791.00	31362.00	1299174.00	0.00	10462327.00	24778084.00	25983473.00
4	Building - Auditorium & Canteen at Panvel	75875261.00	911.00	0.00	75876172.00	3409190.00	911.00	3623304	0.00	7033405.00	68842767.00	72466071.00
5	Building Director Bunglow, Flatlets & Staff Quarters	42505000.00	110444.00	0.00	42615444.00	221259.00	6567.00	2114187	0.00	2342013.00	40273431.00	42283741.00
	TOTAL	**246283121.00**	**2226568.00**	**0.00**	**248509489.00**	**53198801.00**	**39930.00**	**9654217.00**	**0.00**	**62892948.00**	**185616541.00**	**193084320.00**

K. Kumar

S. R...

Narendra Samar & Co. Partner Chartered Accountants

INDIAN INSTITUTE OF GEOMAGNETISM
NEW PANVEL, NAVI MUMBAI – 410 218.

YEAR ENDING 31/03/2014

SCHEDULE – 8(B)

ADVANCES FOR IMMOVABLE PROPERTIES CAPITAL WORKS IN PROGRESS (A)

Particulars	As on 31/03/13	Additions during the year	Deduction during the year	As on 31/03/14
Capital work in progress – Nagpur	297391	0	7877	289514
Capital work in progress – Rajkot (CPWD)	1049315	0	0	1049315
Capital work in progress – Jaipur	29026	0	0	29026
Capital work in progress – Kolhapur	5219391	0	0	5219391
Capital work in progress – CPWD Alibag	1700000	0	0	1700000
Capital work in progress – Allahabad	12196000	44100	0	12240100
Capital work in progress – EGRL	490528	0	0	490528
Capital work in progress – Guest House	1060000	0	1060000	0
Capital work in progress – Auditorium	2138000	0	2138000	0
Capital work in progress – Portblair	27241807	0	0	27241807
Capital work in progress – Flatlets/Dir Bung, Staff Qtrs	2995000	0	2595000	400000
Capital work in progress – Colaba CPWD	115931	0	115931	0
Capital work in progress – Pondicherry	3410807	18600	64111	3365296
Capital work in progress – Silchar (MGCC)	0	0	0	0
Capital work in progress – Shilong	2419948	0	0	2419948
Capital work in progress – Belapur	1621656	0	0	1621656
Capital work in progress – Vishakapatnam	6388	0	0	6388
Capital work in progress – Panvel	5948564	0	0	5948564
Capital Work in progress - Hostel	834466	0	0	834466
TOTAL	**68774218**	**62700**	**5980919**	**62855999**

K. Sharma D.S. Rajput

Narendra Samar & Co. Partner Chartered Accountants

INDIAN INSTITUTE OF GEOMAGNETISM
NEW PANVEL, NAVI MUMBAI – 410 218.

YEAR ENDING 31/03/2014

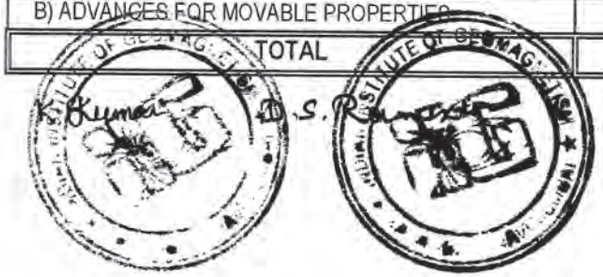
SCHEDULE – 8(B)

ADVANCES FOR MOVABLE PROPERTIES CAPITAL WORKS IN PROGRESS (B)

Particulars	As on 31-03-13	Additions during the year	Deduction during the year	As on 31-03-14
Margin Money	24075000.00	26504000.00	18441548.00	32137452.00
Advances for Laboratory Equipment (Exp.)	689744.00	193307.00	32746.00	850305.00
TOTAL	**24764744.00**	**26697307.00**	**18474294.00**	**32987757.00**

CAPITAL WORKS IN PROGRESS

A) ADVANCES FOR IMMOVABLE PROPERTIES	**62855999.00**
B) ADVANCES FOR MOVABLE PROPERTIES	**32987757.00**
TOTAL	**95843756.00**



INDIAN INSTITUTE OF GEOMAGNETISM

NEW PANVEL NAVI MUMBAI

YEAR ENDED 31-03-2014

INVENTORIES

Sch :11 A (1)

Particulars	Opening Balance	Purchases	Closing Balance	Consumption
Computer Stationery	126695	1917053	129718	1914030
Stationery / Chart Rolls & Printing of stationery : 1) Stationery / Chart Rolls 2) Pringing of stationery	201483	530302	215717	516068
Electrical Goods & Electronic Components	56721	2618662	108424	2566959
Photo Goods	184575	268345	85889	367031
TOTAL	**569474**	**5334362**	**539748**	**5364088**

K. Kumar

D.S. Ramesh

Narendra Samar & Co. Chartered Accountants Partner

INDIAN INSTITUTE OF GEOMAGNETISM

NEW PANVEL, NAVI MUMBAI – 410 218.

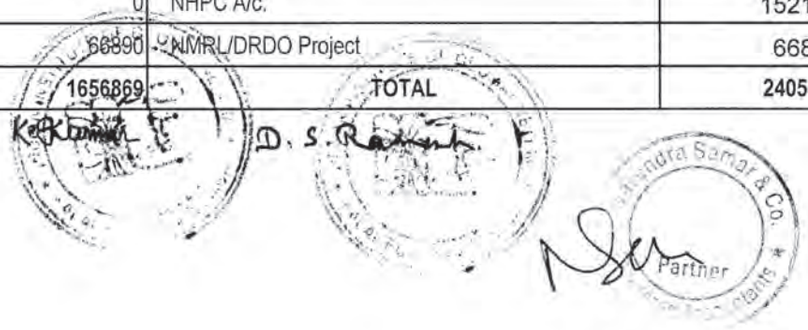
SCHEDULE – 11A(2b)

YEAR ENDING 31/03/2014

ADVANCE AND DEPOSITS WITH OTHERS

AS ON 31/03/13		PARTICULARS	AS ON 31/03/14	
RS.	PS.		RS.	PS.
	76040	Deposit Tele / Telex MTNL		76040
	47730	Deposit MSEB, Alibag		47730
	14200	Deposit LPG Gas (Mumbai & Panvel)		14200
	72100	Deposit Telephones (All outstations)		72100
	2590	Deposit BEST Security		2590
	4700	Deposit BEST for Residential Qtrs.		4700
	16510	Deposit Security Deposit MSEB & MSED, Nagpur		16510
	19420	Deposit Tamilnadu Electricity Board		19420
	272400	Deposit MSEB, Belapur		294300
	40000	Deposit Internet (VSNL)		40000
	384000	Deposit MSEB, Panvel		384000
	23920	Deposit Electricity Tirunelveli		23920
	950	Deposit LPG Gas (All Outstations)		950
	32090	Deposit CIDCO Land		32090
	9747	Deposit Electric Connection GRL		9747
	500	Deposit Telephone Rajkot		500
	8555	Deposit Rajasthan Electricity (Board) Jaipur		8555
	925	GSILI Recoverable		775
	550	Deposit HP Gas, Panvel		550
	1000	Deposit MTNL, Panvel (Guest House)		1000
	700	Deposit BSNL Jaipur		700
	1000	Deposit BSNL Port Blair		1000
	3000	Deposit BSNL Rajkot		3000
	48000	Deposit CIDCO (DIR BUNG & FLAT)		48000
	11000	Deposit UPPCL (Allahabad)		11000
	64333	Deposit Elect. Portblair		64333
	2200	Deposit Security MSED Alibag		2200
	3150	Deposit Pushpak Gas Rajkot		3150
	204825	TDS Receivable		0
	1850	Deposit LPG Gas Portblair		1850
	1900	Deposit LPG Gas Silchar		1900
	320	Deposit Mobile Vodafone		320

100000	Deposit Security at Assam Silchar	100000
0	Foreuign TA receivable	773136
21659	Mr. Ajeet Kumar Maurya	0
1000	Deposit Bank A/c. Rajkot	1000
1000	Deposit Bank A/c. Alibag	1000
1000	Deposit Bank A/c. Vishakhapatnam	1000
1000	Deposit Bank A/c. Silchar	1000
500	Deposit Bank A/c. Nagpur	500
3430	Deposit Electric MSEDCL, Alibag	3430
5170	Deposit Electric Vishakhapatnam	5170
52857	Deposit Nalanda Decor	52857
5000	Deposit Profession Tax A/c.	5000
500	Deposit Reliance Telephone	500
25000	Deposit Victory Automobiles	25000
0	Deposit MSEDCL Belapur quarters	1060
0	Deposit MSEDCL Kolhapur	3480
0	Profession Tax	25200
58	Mr. Manoharlal	0
1600	Mr. Basavaiah	0
0	NHPC A/c.	152175
66890	NMRL/DRDO Project	66890
1656869	TOTAL	2405528



INDIAN INSTITUTE OF GEOMAGNETISM

NEW PANVEL, NAVI MUMBAI – 410 218.

SCHEDULE 11B(1)

YEAR ENDING 31/03/2014

ADVANCE TO STAFF

AS ON 31/03/13	PARTICULARS	AS ON 31/03/14
RS. PS.		RS. PS.
362130	Travelling Allowance	371113
45750	Festival	37500
641327	Leave travel concession	742677
140100	Scooter	151500
3540244	House Building	2085541
0	Foreign T.A.	66647
205400	Computer	198250
860725	Motor Car	839593
20000	TA on Transfer	0
5815676	**TOTAL**	**4492821**

K. Kumar D.S. Ramesh

Narendra Samar & Co. Partner Chartered Accountants

INDIAN INSTITUTE OF GEOMAGNETISM

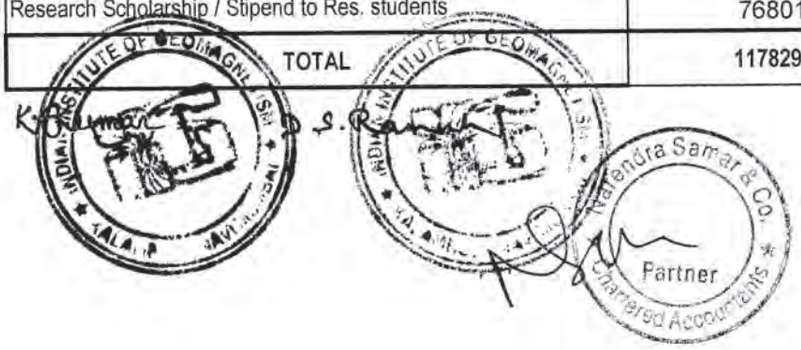
NEW PANVEL, NAVI MUMBAI – 410 218.

SCHEDULE – 20A

YEAR ENDING 31/03/2014

A. SALARIES

PARTICULARS	AS ON 31/03/14	
	RS.	PS.
Pay and Allowances	110149688	
Research Scholarship / Stipend to Res. students	7680101	
TOTAL	117829789	



INDIAN INSTITUTE OF GEOMAGNETISM

NEW PANVEL, NAVI MUMBAI – 410 218.

SCHEDULE – 20B

YEAR ENDING 31/03/2014

ALLOWANCES & BONUS

PARTICULARS	AS ON 31/03/14	
	RS.	PS.
Bonus	210694	
Honorarium	308605	
Overtime	28143	
Children Education Allowance/Reimbursement of Tution Fees	1058114	
TOTAL	1605556	

K. Kumar D. S. Ramesh

Narendra Sarda & Co. Partner Chartered Accountants

INDIAN INSTITUTE OF GEOMAGNETISM

NEW PANVEL, NAVI MUMBAI – 410 218.

SCHEDULE – 21(a)

YEAR ENDING 31/03/2014

TRAVELLING AND CONVEYANCE

PARTICULARS	AS ON 31/03/14	
	RS.	PS.
Travelling, Conveyance and Freight Charges	8773391.00	
Foreign T.A. Expenses	889075.00	
LTC Expenses	1869615.00	
Vehicle Hiring	1164211.00	
TOTAL	**12696292.00**	

K. Kumar D. S. Ramesh

Narendra Samar & Co. Partner Chartered Accountants

INDIAN INSTITUTE OF GEOMAGNETISM
NEW PANVEL, NAVI MUMBAI – 410 218.

SCHEDULE – 21 (b)

YEAR ENDING 31/03/2014

POSTAGE, TELEGRAM AND TELEPHONE

PARTICULARS	AS ON 31/03/14	
	RS.	PS.
Internet charges to VSNL		4279426
Postage and Telegram		249868
Telephone Charges		645189
TOTAL		**5174483**

VEHICLE MAINTENANCE

PARTICULARS	AS ON 31/03/14	
	RS.	PS.
Petrol and Diesel		377244
Repairs and Maintenance to vehicle		175581
TOTAL		**552825**

K. Kumar D.S. Ramesh

Narendra Samar & Co. Partner Chartered Accountants

INDIAN INSTITUTE OF GEOMAGNETISM, MUMBAI
TRUST REGISTRATION NO. AF/2375
SOCIETY REGISTRATION NO. 91/71 GBBS

Schedule-24
SIGNIFICANT ACCOUNTING POLICIES AND NOTES ON ACCOUNTS

A. SIGNIFICANT ACCOUNTING POLICIES;

1) ACCOUNTING CONVENTION:

a) The Financial Statements are prepared under the historical cost convention on the basis of going concern and in accordance with the applicable Accounting Standards issued by ICAI except AS-11, AS-15.

b) The Institute generally follows the mixed system of accounting and recognizes income and expenditure on payment basis except those expenses/income outstanding as on 31/03/2013 are accounted on accrual basis and Government grant and those with significant uncertainties are accounted as cash basis.

2) FIXED ASSETS:

Fixed Assets are stated at their original cost acquisition / installation. Fixed assets are shown net of accumulated depreciation without any adjustment of foreign exchange fluctuation gain (loss).

3) DEPRECIATION

a) Depreciation has been provided on written down value method corresponding to the rates prescribed under Section 32 of Income Tax Act 1961.

b) Assets costing ₹5000/- or less each is fully expenses out in the year of acquisition.

4) CAPITAL WORK IN PROGRESS

Capital Work-in-progress is stated at the amount spent up to the date & Advances made to respective parties of the Balance Sheet, in case the same is backed by asset. In case if the expenditure is not backed by asset the same is recorded as Pre Operative Expenses (Project) under the head Miscellaneous Expenditure.

Leasehold land is amortized over the period of lease.

5) GRANT

Government grants are accounted on Receipt basis.

6) INVENTORIES

Closing Stock was valued at cost or market price whichever is less on FIFO basis.

7) RETIREMENT BENEFITS:

Contribution for various retirement benefit Debited to Income and Expenditure Account AS-15 is not followed in the case of gratuity & leave encashment.

8) CONTINGENT LIABILITIES & PROVISIONS :

No provision is made for liabilities, which are contingent in nature, but, if material, the same are disclosed by way of notes to the accounts & accounted on payment basis.

9) GENERAL:

Accounting policies not specifically referred to above are consistent with generally accepted accounting principles.

B. NOTES TO ACCOUNTS

1. Previous year's figures have been regrouped, wherever necessary.
2. Margih money in form of FDR ₹321.00 lacs
3. Properties worth ₹113,18,789.00 (movable ₹8,83,000.00 and immovable ₹ 104,34,989.00) previously belonging to IMD and in occupation of the Institute have not been accounted for in the Balance Sheet as the same have not yet been conveyed to the Institute by the Government of India. Realizable value of movable properties worth ₹8,83,000/- is in occupation of IIG previously belong to IMD still not conveyed to IIG is now NIL.
4. Contingent Advances-

   Contingent Advances balance as on 31.03.2014 is ₹28,42,530/-. Out of the above amount, ₹11,96,030/- has been settled upto 31.07.2014.
5. As per notification no. BPI 1390/317/(75)-6 dated 5th March 1991 issued by the Government of Maharashtra; this Institute has been exempted from all provisions of the Bombay Public Trust act, 1950, except those relating to registration contained in Chapter IV of the said Act.
6. The management has carried out Physical verification of closing stock.
7. Physical Verification & reconciliation of Fixed assets with books was not carried out by management.
8. Capital work in progress as on 31.03.14 is verified and certified by management / respective authorities.
9. Income & Expenditure Account credit balances include a substantial major portion of Grants-in-Aid received from Government of India and utilized for acquisition of immovable properties and advances made to purchase of immovable properties. The same, however, is not transferred to Trust Fund or Corpus Account, nor is the account ascertained.

10. Advance for Movable property Capital works includes ₹6,03,900 (paid in 2002-03) represents the cost of Lab equipments lost in transit. The amount has been included under the head Advance for Lab Equipment. No provision has been made in the books for the same.

11. The Interest on Staff Advances is accounted on Receipt basis.

12. Retirement fund of the employee is solely managed by IIG only in their proprietary account & all contribution of employee & employer is kept by IIG in separate bank account, it should be kept separate from business of IIG in different trust.

For, Narendra Samar & Co.
Chartered Accountants
Firm No. 126415W

Narendra Samar & Co. Partner Chartered Accountants

Narendra Samar
(Partner)
Membership No.119521

Place: Thane
Date: 01/08/2014

INDIAN INSTITUTE OF GEOMAGNETISM ★ KALAMBOLI, NAVI MUMBAI ★

Indian Institute of Geomagnetism

KALAMBOLI HIGHWAY, NEW PANVEL (W), NAVI MUMBAI 410 218
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Cover page : The Earth consists of four vast reservoirs, the Atmosphere, the Hydrosphere, the Geosphere and the Biosphere, with constant interflow of energy and matter.

Felicitation of Dr. Carol Finn, President, AGU by the Director, IIG during her visit to the Institute

IIG participants at the AOGS meeting, Brisbane, Australia

IIG participants at the Golden Jubilee celebration of IGU, Hyderabad