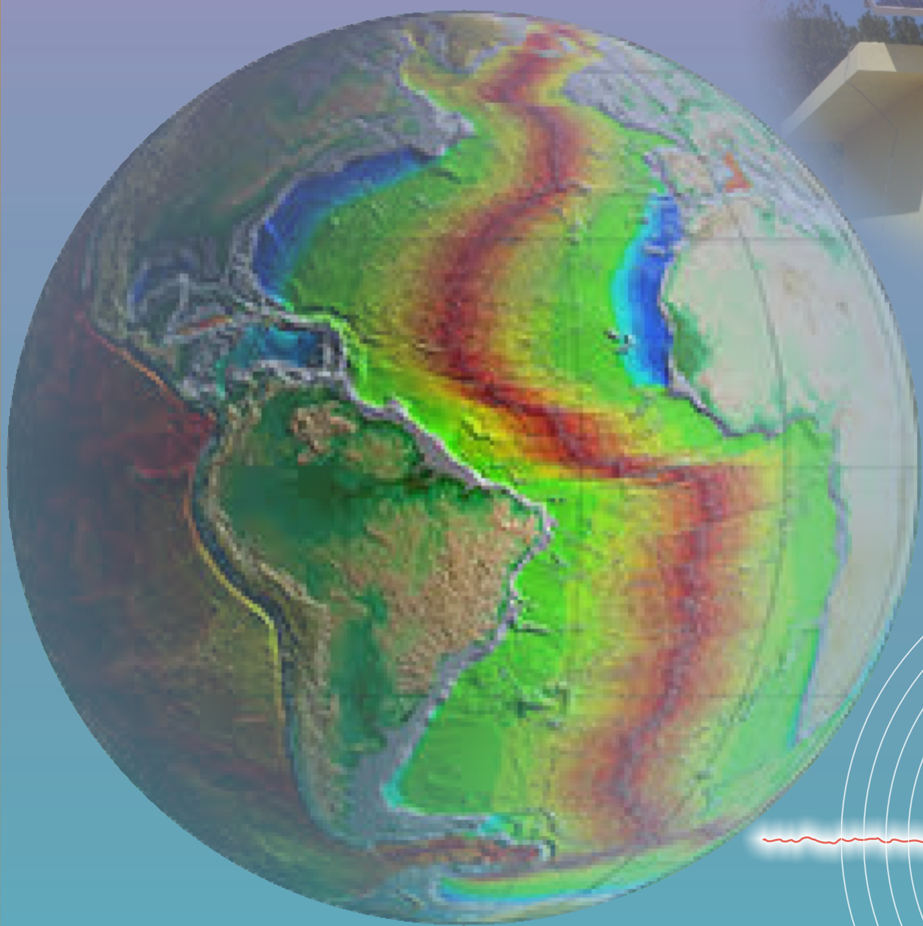
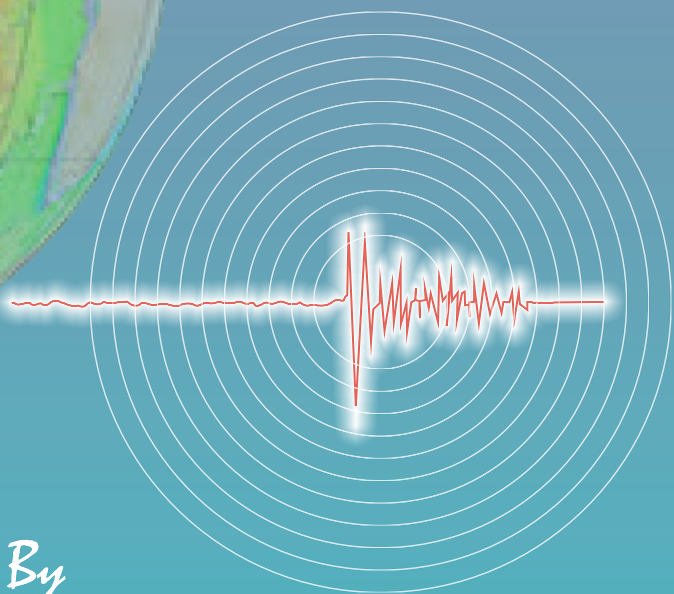
Council of Scientific & Industrial Research-North East Institute of Science & Technology

e-ABSTRACT VOLUME

International Virtual Workshop on Global Seismology & Tectonics

14-25th September 2020





Organized By

Geoscience & Technology Division
North East Institute of Science & Technology
(Council of Scientific & Industrial Research)
Jorhat, Assam, India

Dr. G. Narahari Sastry, FNASc, FASc, FAPAS, FTAS
SERB - J.C. Bose National Fellow
DIRECTOR
CSIR - North East Institute of Science & Technology (CSIR-NEIST)
(Ministry of Science &Technology, Govt. of India)
Jorhat-785006, Assam, India

Welcome Message

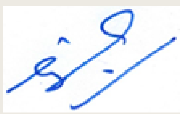
Greetings from CSIR NEIST, Jorhat !!!

IVWGST-2020 is one of the flagship event of our institution for the year 2020 which aims to boost the morale of the students and researchers, during the distressing pandemic situation, by provisioning opportunities to interact with eminent personalities of their research interest in the domain of Seismology and Tectonics

I appreciate one and all participating in the International Virtual Workshop on Global Seismology & Tectonics (IVWGST-2020). I'm sure the brainstorming sessions throughout the course of the workshop will immensely augment your skills and expertise. I am thankful to all the keynote speakers, representing different countries and diverse scientific forums, for volunteering to disseminate critical knowledge and skills within the broad domain of Seismology and Tectonics. Their passion and interest towards promulgating advanced techniques and scientific information are duly acknowledged. The lecture sessions aims in imparting momentous information's on impending topics of estimating earthquake completeness, large intraplate earthquakes in India, earthquake ground motion and damages, tectonics and seismicity of Indonesia and Southeast Asia, deformational processes in the Himalayan megathrust, earthquake precursor/forecasting, seismic hazard and seismic source modelling, tectonics of NE-India, the poisson assumptions and several others.

The e-Abstract volume documents abstract note of talks presented during IVWGT-2020 as live webinar series. It also binds sceptic research knowledge, with impetus on contemporary trends, of the participants in the form of abstracts. The e-abstract volume to be distributed and read by a wide scientific community would serve as a medium of propagation of research erudition across global geoscience forums. I thank all authors who have submitted an abstract to be included in the e-abstract volume.

I am thankful to members of our advisory board, Organizing committee, Convener, Co-conveners, Technical Committee, Moderators and associate Members for their hard work and acumen towards IVGWT-2020 with their preferred modality. Particular thanks in this regard to Geoscience and Technology Division, CSIR-NEIST for initiating conduct of IVGWT-2020.



G Narahari Sastry

Dr. G. Narahari Sastry

Director's Biography

Dr G Narahari Sastry has obtained his early education in Khammam, Telangana and obtained his B.Sc. and M.Sc. from Osmania University (campus), Andhra Pradesh and Ph.D from University of Hyderabad. After a couple of post-doctoral stints, he started his independent research career in 1997 at Pondicherry University, and moved to CSIRIICT in 2002, to head centre for molecular modeling. He is a professor of AcSIR in chemistry and lifesciences disciplines. Dr Sastry's research interests are theroetical and computational chemistry, computational biology, computer aided molecular design and chemoinformatics. Dr Sastry has made fundamental contributions in the area of noncovalent interactions and developed several important concepts in this area. His group is interested to apply the data science approaches, and developing indigenous software, Molecular Property Diagnostic Suite. Several of his computational predictions have seen experimental realization. Besides publishing independently, the group also has active collaboration with several experimentalists and strongly believe that 'theory experiment interplay is indispensable' for the progress of science. He has successfully guided 22 Ph.D students and published more than 275 papers. Currently 10 members are doing Ph.D and postdoctoral studies in the group. These publications received over 10,000 citations, with an h-index of 50. Dr Sastry is a J C Bose National Fellow (2015). He was awarded with Shanthi Swarup Bhatnagar Prize in Chemical Sciences (2011), considered as one of the highest prize for science and engineering in India, National Bioscience award (DBT) 2009, one of the highest for Lifesciences in India, Swarnajayanthi Fellowship 2005 (DST), B.M. Birla award for 2001, B C Deb Memorial award (2009), CRSI Medal 2011, and AvH Fellowship. He has delivered more than 350 invited lectures which include talks in national and international conferences. He was a visiting professor at IMS, Japan; LMU, Munich, Germany; Jackson State University, USA, and Kyushu Univesity, Japan. He was elected as a Fellow of National Academy of Sciences (FNASc), Fellow of the Indian Academy of Sciences (FASc), Fellow of Association of Biotechnology and Pharmacy, Telangana State Academy of Sciences (Founder Fellow) and Andhra Pradesh Academy of Sciences (FAPAS). He is a regular reviewer to some prestigious journals and also in the editorial board of some journals.

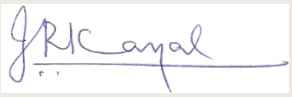
Prof. J. R. Kayal, M. Sc., AISM, Ph. D. (N Z)
Former Deputy Director General (Geophysics), Geological Survey of India,
CSIR Emeritus Scientist, Jadavpur University, Kolkata,
Adjunct Professor: Indian School of Mines, Dhanbad 826004,
Guest Faculty: UNESCO Training Courses, South Asia,
Presently: Adjunct Professor: NIT-Agartala.
(*Sessions Chairperson and Advisor, IVWGST-2020*)

Preface

The International Virtual Workshop on Global Seismology & Tectonics (IVGWT-2020), September 14-25, 2020 is a great effort, first of its kind, by the Geoscience and Technology Division, CSIR-NEIST to disseminate knowledge and experience to the under Graduate/Post-graduate/PhD students, young researchers, scientists and earthquake engineers. The IVWGST-2020 addresses basic problems towards global as well as local earthquake seismology and tectonics. This Workshop is an opportunity for all of us, nationally and internationally, to enhance our knowledge in earthquake seismology and tectonics, and it unites the scientific community, seismologists in particular, on an important interactive international platform through this 12-day Workshop The Workshop encompasses a wide range of lectures on *earthquakes and tectonics* including local and global seismic waves, seismic source modelling, fault plane solutions, seismic tomography, active-fault identification and its tectonic implications, earthquake precursors, earthquake forecast, seismic hazards etc.

I express my sincere thanks and gratitude to Prof G N Sastry, Director, CSIR-NEIST, Jorhat, Assam for extending his generous support, encouragement and guidance for this venture on national and international collaboration, the IVWGST-2020. I thank the participants for their keen interest and active participation at the IVWGST-2020. Sincere thanks to Dr. Santanu Baruah, Convener, IVWGST-2020, for his innovative thoughts, strategies and enormous efforts and patience in developing strong working relationships among scientific communities in different parts of the world. I highly appreciate the working group behind the IVWGST-2020 and the members of the Geoscience and Technology Division, CSIR-NEIST. My hearty congratulations and sincere gratitude to all the speakers from different parts of the World: United States of America, Canada, Malta, Iran, Nigeria, Bangladesh and India for their much informative and enlightening lectures, which will benefit in a big way to more than 900 registered participants of the World in this workshop.

The e-Abstract Volume covers abstracts of all the lectures presented at the IVWGST-2020, live webinar series. The IVWGST-2020 e-Abstract Volume is well documented with the informative materials provided by the speakers. I convey my sincere thanks to all the authors and speakers who have contributed to the e-Abstract Volume. My sincere thanks and gratitude to the Advisory Board, Organizing Committee, Convener, Co-conveners, Technical Committee, Moderators and the associate Members for their persistent untiring efforts to make the IVWGST-2020 not only a great success but also in achieving a milestone to knowledge dissemination to the younger generation in India and abroad.



J.R. Kayal

Dr.Saurabh Baruah, Ph. D.
Winter over member, 18th Indian Scientific Expedition to Antarctica
Chief Scientist
CSIR - North East Institute of Science & Technology (CSIR-NEIST)
(Ministry of Science &Technology, Govt. of India)
Jorhat-785006, Assam, India
(Sessions Co-Chairperson and Advisor, IVWGST-2020)

Session Co-Chairperson's e-Message

At a time when the whole world is brought to a standstill due to CoVID-19 pandemic, virtual events have been rare source of motivation and inspiration with respect to attributing indulgence with scientific and academic activities. In a blessing in disguise, the virtual events have facilitated a conduit for direct access with experts and pioneers from across the globe. I am highly privileged to be a part of the organizing committee of IVWGST-2020 which aims high to boost the morale of the students and researchers by facilitating opportunities to interact with eminent Professors having research interest in the domain of Seismology and Tectonics. I am indebted to the Convener, **Dr.SantanuBaruah**, for formulating the splendid idea to organize the event under the dynamic leadership of the Director of CSIR NEIST, Dr. G N Sastry.

I wish the workshop a grand success !!!

Saurabh Baruah

Dr. Manoj K. Phukan, Ph. D.
Head, Geoscience & Technology Division
CSIR - North East Institute of Science & Technology (CSIR-NEIST)
(Ministry of Science &Technology, Govt. of India)
Jorhat-785006, Assam, India

e-Message from Head of the Department, GSTD, CSIR-NEIST

The workshop, organized by Geoscience and Technology Division, CSIR-NEIST aims explicitly to identify the most critical challenges that need to be addressed to progress research in Global Seismology & Tectonics. International Virtual Workshop on Global Seismology & Tectonics (IVWGST-2020) focuses on methods by which it might be addressed. The workshop significantly targets wide participant'sthroughout the world of interdisciplinary community of Graduate/Post-Graduate/PhD students, researchers and scientists, of Geology, Geophysics and Physics. The workshop solicited talks in earthquake completeness, ground motion and damages,seismotectonics, earthquake precursor and forecast, seismic hazard and seismic source modelling, the poisson assumptions and many more.

We as a team, the Conveyor IVWGST-2020 and Geoscience and Technology Division, CSIR-NEIST convey our hearty congratulation to the speakers, for theirunsurpassed choice of theinformativelectures. The outstanding active speakers are from different parts of the world (United States of America, Canada, Malta, Nigeria, Iran, Bangladesh and India) which will provide immense knowledge for the participants. My heartiest thank you for your consideration with enthusiasm which will hugelyinspireour participants. The aim of IVWGST-2020 is to impart insight knowledge on global seismology and tectonics.The book of abstract accrues the extracts of the talks presented at the IVWGST-2020, live webinar series. The IVWGST-2020 and abstracts enlightens an insight to the imminent problems and its solution towards global seismology and tectonics.We convey sincere thank you to all the authors who have contributed for IVWGST-2020, book of abstract. I also convey thank you to advisory board, Organizing committee, Convener, Co-conveners, Technical Committee, Moderators and associate Members for their unflagging support towards IVWGST-2020 with their resources. I as well as on behalf of IVWGST-2020 team members specially thanks in this regard to Director, CSIR-NEIST for facilitating us to conduct IVWGST-2020.

Manoj Kumar Phukan

Dr.Santanu Baruah, Ph. D.
Convener
International Virtual Workshop on Global Seismology and Tectonics
IVWGST-2020

e-Message from the Convenor

It is my great pleasure to present the e-Abstract volume of the Internationals Virtual Workshop on Global Seismology and Tectonics, IVWGST-2020. The virtual talks and lectures were on the rise with sporadic hosting in the pre-CoVID-19 era, the impacts and potentials of e-events were hugely underestimated due to preferences of attending physical sessions over e-sessions. The jubilant participation of students, researchers, academicians and scientists in IVWGST-2020 from **31 countries** (***1028 participants***), including *Albania, Algeria, pArgentina, Australia, Bangladesh, Canada, Colombia, Comalcalco Tabasco, Democratic Republic of Congo, Dominican Republic, Ecuador, Iceland, Indonesia, Iran, Israel, Japan, Malaysia, México, Myanmar, Nepal, Nigeria, Philippines, Poland, Russia, Singapore, Sri Lanka, Taiwan, Tajikistan, Turkey* and *US* apart from *India*, is a testimony to the fact. It is hugely inspiring to see the participation of people from beyond the domains of Geology, Geophysics and Physics. We are sure that such virtual events are set to create a new order in knowledge sharing and dissemination.

We were honored to have Prof. Andrew Michael, USGS, Prof. Walter Mooney, USGS, Prof. Susan Houge, USGS, Dr. Nicholas, USGS; Prof. Djorde Grujic, Dalhousie University; Prof. Ramesh Singh, Chapman University; Prof. Mehdi Zaré, IIEES, Iran; Prof. Tahmeed M. Al-Hussaini, BUET, Bangladesh; Prof. Sebastiano D'Amico, Uni. of Malta; Prof. A. A. Adepelumi, O. A. University; Prof. J R Kayal, Former Dy DG, GSI; Dr V. K. Gahalaut, CSIR NGRI; Dr. Imtiaz A Parvez, CSIR-4PI; Dr RB S Yadav, Kurukhetra University, India; Dr Saurabh Baruah, CSIR-NEIST the Key Note Speakers on this special occasion. I would like to thank all of them for accepting our request for delivering talks in this virtual event.

The e-abstract volume presents a synoptic glimpse of classical and contemporary research endeavours and trends primarily in the field of Geology, Geophysics and Physics apart from interesting inculcation of research related to CoVID-19. In my opinion, this volume is the first ever e-Abstract volume of a virtual workshop published in a pandemic era.

As the convener of the conference, I extend my gratitude to Prof.G Narahari Sastry, Director CSIR-NEIST Jorhat for his kind help and all kind of support in organizing this event. It really feels so amazing working in his positive environment. Working under his management is indeed a great opportunity for any individual like me. I thank once again Prof. Andrew Michael, USGS; Prof.J R Kayal, Former Dy DG, GSI; Dr. Saurabh Baruah, CSIR-NEIST; Dr.Jatin Kalita, Head, RPBD, CSIR NEIST; Dr. Manoj K Phukan, Head, GSTD for their valuable support and guidance.

I thank all the members of the organizing committee for extending their valuable time in organizing the program and all the authors, reviewers, and other contributors for their sparkling efforts and their belief in the excellence of IVWGST-2020.

SANTANU BARUAH

Santanu Baruah

Table of Contents

6. Title: Numerical estimation of 2D and 3D topography effects on strong ground motion

Author(s): Vishal, J.P. Narayan

7.Title: Detection of seismic quiescences before 1991 Uttarkashi (M_w 6.8) and 1999 Chamoli (M_w 6.6) earthquakes and its implications for stress change sensor.

Author(s): Prasanta Chingtham, & J L Gautam

8.Title: Spatio-temporal variation in the frequency-magnitude distribution in Garhwal-Kumaon NW Himalaya and its seismotectonic implications

Author(s): Anil Tiwari *et al*

9.Title: Logic tree approach in probabilistic seismic hazard analysis of Saveh

Author(s): Samira Fakhraeian *et al*

10.Title: Generation of a homogenized earthquake catalog for North-East India and its vicinity in MATLAB

Author(s): Abhileen Chatterjee *et al*

11.Title: A review on the tectonic settings of Assam and its mineral resources.

Author(s): Jonali Medhi

12.Title: Variation of strain rates in northeast India and seismic hazard potential

Author(s): Anup K Sutar *et al*

13.Title: Analysis of Focal Mechanism Solutions of Shallow Focus Earthquakes and Deformation Mechanism of the Indo-Myanmar Ranges, Northeast India

Author(s): Khundrakpam Kumarjit Singh *et al*

14.Title: Potential seismic hazard scenario of Shillong city, Meghalaya, estimated through Probabilistic Seismic Hazard Assessment (PSHA) Technique

Author(s):Goutam Kashyap Boruah *et al*

15.Title: Correlation between seismic crustal anisotropy with seismogenic stress field beneath Shillong – Mikir Plateau and its vicinity of North East India

Author(s): Antara Sharma and Chandan Dey

16. Title: Analysis and Interpretation of Magnetic data in and around the Kopili Fault.

Author(s): Prachurjya Borthakur and Chandan Dey

17. Title: Studying complex local structural pattern of the Kopili Fault Zone using an integrated approach of optical, radar and gravity satellite data

Author(s): Dey *et al*

18. The multifractal detrended fluctuation analysis (MF-DFA) and anomalies in geomagnetic total field intensity prior to Mw 5.5 earthquake

Author(s): Chetia *et al*

19. Title: Spatial Heterogeneity of Kopili Fault: A statistical approach based on Morans correlogram

Author(s): Saadah Majid *et al*

20. Title: Difference between North Korea's Explosion (09 Sep 2016) and Earthquakes

Author(s): Jamileh Vasheghani farahani

e-Abstract Volume for International Virtual Workshop on Global Seismology & Tectonics

Published By: ***The Organizing Committee***
International Virtual Workshop on Global Seismology & Tectonics, 14-25 September 2020

e-Workshop Information: Inauguration: 14 Sept. 2020 @ 09:15 am (Time Zone: IST, +5:30 hrs GMT)

e-Schedule:

14 September @ 09:30 am IST 13 September @ 09:00 pm PDT	**Andrew Michael, USGS, USA** Why it is hard to count Earthquakes: Estimating Catalog Completeness
15 September @ 10:00 am IST 14 September @ 09:30 pm PDT	**Walter D. Mooney, USGS, USA** The Tectonics and Seismicity of Indonesia and Southeast Asia
16 September @ 03:00 pm IST 16 September @ 06:30 am ADT	**DjordjeGrujic, Dalhousie Uni., Canada** Spatial and temporal interplay between "viscous" and "brittle" deformational processes in the Himalayan megathrust
17 September @ 09:30 am IST 16 September @ 09:00 pm PDT	**Nicholas Vander Elst, USGS, USA** *Forecasting aftershocks with the epidemic type model*
18 September @ 10:00 am IST 17 September @ 09:30 pm PDT	**Ramesh Singh, Chapman University, USA** Ground, Borehole and Satellite Observations for Search of Reliable Earthquake Precursors
19 September @ 11:00 am IST	**RBS Yadav, Kurukshetra University, India** Coulomb stress modeling and seismicity triggering: A perspective on future seismic hazard
19 September @ 07:30 pm IST 18 September @ 07:00 am PDT	**Susan E. Hough, USGS, USA** Earthquake Ground Motions and Damage: The Long and the Short of It
20 September @ 11:00 am IST	**J. R. Kayal, GSI, India** Recent Strong and Large Intraplate Earthquakes in India
20 September @ 11:00 am IST	**SaurabhBaruah, CSIR NEIST, Jorhat** Complex seismo-tectonics of Northeast India
21 September @ 11:00 am IST 21 September @ 09:00 am IRDT	**Mehdi Zaré, IIEES, Iran** Why the seismic hazard zoning maps are uncertain and should be revised using new Seismic Source Modeling
22 September @ 09:30 am IST 21 September @ 09:00 pm PDT	**Andrew Michael, USGS, USA** The Poisson Assumption: Applications in Spite of Clustering
23 September @ 11:30 am IST 23 September @ 12:00 am BST	**Tahmeed M. Al-Hussaini, BUET, Bangladesh** New Seismic Design Provisions for Updated Bangladesh National Building Code (BNBC-2017) with reference to Seismic Hazard Assessment Studies
23 September @ 07:30 pm IST 23 September @ 04:00 pm CEST	**Sebastiano D'Amico, Uni. of Malta, Malta** The challenge of computing seismic hazard maps and incorporating site effects
24 September @ 03:00 pm IST 24 September @ 10:30 am WAT	**A. A. Adepelumi, O. A. University, Nigeria** Seismicity of Africa
25 September @ 10:00 am IST	**V. K. Gahalaut, CSIR-NGRI, India** Tectonics of Indo-Burmese arc
25 September @ 07:30 pm IST	**Imtiaz A Parvez, CSIR-4PI, India** Earthquake Hazard Studies in India

e- Brochure

International Virtual Workshop

On

Global Seismology & Tectonics

Geoscience & Technology Division
North East Institute of Science & Technology
(Council of Scientific & Industrial Research)
Jorhat, Assam, India

Webinar Series

LIVE

International Virtual Workshop on Global Seismology & Tectonics

14-25th September 2020

Institute at a Glance:

North East Institute of Science and Technology (NEIST), Jorhat, Assam, a constituent establishment of Council of Scientific and Industrial Research (CSIR), New Delhi, has been engaged in multidisciplinary R&D work relevant to the country in general and North East of India (NE India) in particular. The Geoscience & Technology Division (GSTD) of CSIR-NEIST has been continuously monitoring the seismicity of NE India since 1982. The division publishes the Annual Seismological Bulletin and maintains the Seismic Database for NE India. Seismic hazard and vulnerability assessment of the populated cities & urban areas in NE India has been some major programs of the division apart from conducting geotechnical/geophysical consultancy services.

Aim of the Virtual Workshop:

Due to severe physical communication constraints brought about by the CoVID-19 pandemic situation, the practice of disseminating knowledge and ideas through webinar, a live interactive event where attendees join via their desktop or mobile device over the internet, have significantly proliferated. While research activities, including research exchange and collaborations, during this unprecedented situation have decelerated, it is imperative to boost the morale of the students and researchers by provisioning opportunities to interact with eminent personalities of their research interest. In course with this, the virtual workshop, in the form of webinar series, aims in inviting eminent experts in the Geoscience domain, from across the globe, to impart scientific lectures catering to Graduate/Post Graduate/PhD students, apart from researchers and scientists, of Geology and Geophysics.

Targeted Discipline

- Physics
- Geophysics
- Geology

Targeted Group

- Graduate/ Post Grad. Students
- Ph.D. Scholars
- Scientists Academician Researchers

Registration/Workshop Link

Event Details — Scan QR Code — Click Here

Registration Link — Scan QR Code — Click Here

Joining Link — LIVE — Click Here

Workshop joining link will be sent to the registered email of all the participants

Workshop Info.

Registration: 1st Sept. 2020 onwards
Deadline: 11th Sept. 2020
Acceptance: 12th Sept. 2020
Inauguration: 14th Sept. 2020 @ 09:15 am
(Time Zone: IST, +5:30 hrs GMT)

Contact
Dr. Santanu Baruah
gstdneist@gmail.com +91-9435514805

International Virtual Workshop on Global Seismology & Tectonics

14-25th September 2020

Webinar Schedule

Inauguration 14th September, 2020 @ 9:15 am IST (+5:30 GMT)

SPEAKERS

Andrew Michael, USGS, USA

Why it is hard to count Earthquakes: Estimating Catalog Completeness

14th September @ 09:30 am IST
13th September @ 09:00 pm PDT

Walter D. Mooney, USGS, USA

Tectonics and Seismicity of Indonesia and Southeast Asia

15th September @ 10:00 am IST
14th September @ 09:30 pm PDT

Djordje Grujic, Dalhousie Uni., Canada

Spatial and temporal interplay between "viscous" and "brittle" deformational processes in the Himalayan megathrust

16th September @ 03:00 pm IST
16th September @ 06:30 am ADT

Nicholas Vander Elst, USGS, USA

Forecasting aftershocks with the epidemic-type model

17th September @ 09:30 am IST
16th September @ 09:00 pm PDT

Ramesh Singh, Chapman University, USA

Ground, borehole and satellite observations for search of reliable earthquake precursors

18th September @ 10:00 am IST
17th September @ 09:30 pm PDT

RBS Yadav, Kurukshetra University, India

Coulomb stress modelling and seismicity triggering: A perspective on future seismic hazard

19th September @ 11:00 am IST

Susan E. Hough, USGS, USA

Earthquake Ground Motions and Damage: The Long and the Short of It

19th September @ 07:30 pm IST
18th September @ 07:00 am PDT

J. R. Kayal, GSI, India

Large Intraplate earthquakes in India

20th September @ 11:00 am IST

Saurabh Baruah, CSIR-NEIST, India

Complex seismo-tectonics of northeast India

20th September @ 07:30 pm IST

Mehdi Zaré, IIEES, Iran

Why does seismic hazard zoning maps are uncertain and should be revised using new seismic source modelling

21st September @ 11:00 am IST
21st September @ 09:00 am IRDT

International Virtual Workshop on Global Seismology & Tectonics

14-25th September 2020

Webinar Schedule

SPEAKERS

Andrew Michael, USGS, USA

The Poisson Assumption: Applications in Spite of Clustering

22nd September @ 09:30 am IST
21st September @ 09:00 pm PDT

Tahmeed M. Al-Hussaini, BUET, Bangladesh

New Seismic Design Provisions for Updated Bangladesh National Building Code (BNBC-2017) with reference to Seismic Hazard Assessment Studies

23rd September @ 11:30 am IST
23rd September @ 12:00 am BST

Sebastiano D'Amico, Uni. of Malta, Malta

The challenge of computing seismic hazard maps and incorporating site effects

23rd September @ 07:30 pm IST
23rd September @ 04:00 pm CEST

A. A. Adepelumi, O. A. University, Nigeria

Seismicity of Africa

24th September @ 03:00 pm IST
24th September @ 10:30 am WAT

V. K. Gahalaut, CSIR-NGRI, India

Tectonics of Indo-Burmese arc

25th September @ 10:00 am IST

Imtiaz A Parvez, CSIR-4PI, India

Earthquake hazard studies in India

25th September @ 07:30 pm IST

GUIDELINES

- The virtual workshop, in the form of a series of lectures, would be held via Microsoft Teams, an internet based visual communication platform.
- The participants are requested to download and install Microsoft (MS) Teams software in their desktop or mobile devices.
- The participants are expected to mute and disable their audio and camera interfaces, respectively during lecture by the speakers and suitably turn the same on only if direct interaction during Q&A session is attempted.
- E-certificate shall be provided to participants upon request, however, with at least 80% overall attendance in the virtual workshop.

International Virtual Workshop on Global Seismology & Tectonics

14-25th September 2020

Organizing Committee

PATRON

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International Virtual Workshop on Global Seismology & Tectonics

14-25th September 2020

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Dr. Chinmoy Rajkonwar
CSIR-NEIST

Bubul Bharali
Pachhunga Univ. College

e- Abstracts from Key Note Speakers

International Virtual Workshop

On

Global Seismology & Tectonics

1. Topic: Why it is hard to count Earthquakes: Estimating Catalog Completeness

Andrew Michael, USGS

Abstract:

Once upon a time, such as when I started my career, to get an earthquake catalog was a difficult process and you had to write to the network and ask them to send you the data, perhaps as a magnetic tape. Now it is much easier because you can simply search and download the data from institutions such as the USGS (https://earthquake.usgs.gov/earthquakes/search/) or the International Seismological Centre (http://www.isc.ac.uk/iscbulletin/search/catalogue/). This advance is a good thing. But it also means that a researcher may not be in contact with the people who created the catalog who can advise them on its strengths and weaknesses. And this is important because earthquake catalogs are not data. Seismograms are data. Lists of event times, locations, and magnitudes are the product of analyzing seismograms. Over time, seismic networks have also gotten much better with more stations, higher quality seismometers, digital recording, and improved analysis methods. And these advances are also good things. However, it is important to understand how they affect earthquake catalogs. One clear change is that earthquake catalogs are include more and more earthquakes at smaller magnitudes. If we don't understand these issues then we may have biased counts of earthquakes which can affect estimates of earthquake rates for seismic hazard assessment and cloud our understanding of whether earthquake rates change over time. In this tutorial, I will show some cases where this is important and how to account for these issues in your own work.

Presenter biography

Andrew Michael

Andrew Michael has been a geophysicist with the U.S. Geological Survey's Earthquake Science Center in Menlo Park since 1986 where he combines observations of earthquake processes and statistical models to determine long-term and short-term earthquake probabilities, to evaluate proposed earthquake prediction methods, and to better understand how stress and structure function as part of the seismogenic process. A graduate of MIT (B.S., 1981) and Stanford University (M.S., 1983, Ph.D. 1986), he has authored over 100 papers and reports. He was the Editor-in-Chief of the Bulletin of the Seismological Society of America from 2004 to 2010, served on the society's Board of Directors from 2014 to 2019 and was its President from 2017 to 2018. In 2011, for that work, he received the Society's Distinguished Service award. His outreach efforts include founding the Earthquake Science Center web site (quake.usgs.gov which became part of earthquake.usgs.gov) to facilitate the rapid dissemination of earthquake information and a lecture and performance titled "The Music of Earthquakes".

2. Topic: Tectonics and Seismicity of Indonesia and Southeast Asia

Walter D. Mooney, USGS, USA

Abstract:

South Asia is an ideal place to study plate tectonic processes because it includes the greatest diversity of plate boundaries on Earth. Three major plates converge in South Asia, the Indian-Australian, Pacific and Eurasian plates. In addition, there are several smaller plates, such as the Philippine Sea, Carolina, Banda Sea, and other micro-plate. Despite this complexity, there are large portion of South Asia that have a relatively simple tectonic setting. For example, oceanic lithosphere of the Indian-Australian plate subducts quite uniformly beneath the Indonesian islands of Java and Sumatra and has been the site of many large (Magnitude (M) 8) and great M 9 earthquakes. The Java and Sunda trench are therefore a classic ocean-continent collision. In contrast, the continental shelfnorth of Australia subducts beneath the Timor trough and oceanic domain of the Banda Sea, make this a continent-ocean collision. Eastern Indonesia is a collage of ocean-ocean and ocean-island arc subduction systems, such as the Molucca and Celebes Sea collision zones. We illustrate the structure of these active subduction systems using maps and cross section of the seismicity and focal mechanisms of this region based on data from the past 20 years.

Presenter biography

Walter D. Mooney

Prof. Walter Mooney is a research seismologist and geophysicist at the U.S. Geological Survey, Menlo Park, California. He is also a AGU member since 1974 (and Fellow since 1996). His major interest is global Earth crustal structure and tectonics, particularly of the continental lithosphere. Mooney was the branch Chief of Seismology from 1994 to 1997. He has led field work throughout North and South America and participated in extensive research affiliations with colleagues in Mexico, Europe, Russia, China and Taiwan, Japan, India, Australia, New Zealand, East Africa. Mooney is a consulting Professor of Geophysics, Stanford University, and a visiting faculty at the following institutions: University of Karlsruhe and Kiel University, Germany, University of Paris and University of Strasbourg, France, Rice University, and the California Institute of Technology. Finally, he is the Program Leader for the USGS contribution to the Indian Ocean Tsunami Warning System and has extensive experience at leading training.

3. Topic: Spatial and temporal interplay between "viscous" and "brittle" deformational processes in the Himalayan mega thrust

Djordje Grujic, Dalhousie University, Canada

Abstract:

Continuum of stress, strength, slip and creep in the subduction zone plate interfaces is realized by various mechanisms of stress loading the seismogenic zone of a megathrust by creep in its deeper, ductile part. In contrast, viscoelastic deformation, poroelasticity, and ductile flow lead to dispersion and attenuation of seismic waves down dip the seismogenic zones. Most of the understanding of these interactions was acquired through seismological and theoretical studies.

We investigate such megathrust system across a range of observation scales and approaches, including field observations, microanalyses, innovative geochronology, and numerical modeling. The outcrops of the main Himalayan structures expose a sequence from ductile shear zones to brittle faults. As all these structures merge into the Himalayan basal décollement, the Main Himalayan thrust, it can be safely assumed that the rocks now at the surface were within the MHT at the time of their deformation. Himalayan thrusts therefore collectively crosscut many lithologies and have operated over broad ranges of pressure, temperature, and strain rates. From north to south, from older to younger, the sequence of outcrops of mylonite, ultramylonites, cataclasites, to fault gouge represent distinct zones into which deformation has localized.

Microstructural and textural analyses of quartz mylonites from the Main Central thrust allow identification of switches of deformation mechanisms caused by reductions in pressure and temperature during exhumation, and they provide quantitative constraints on stress history. At some localities there is an evolution of samples experiencing shifts to higher stress deformation that may be a result of interaction between end-member mechanisms where viscous flow cannot accommodate all the imposed displacement, which leads to "semi-brittle" deformation. Alternatively, the pulses of high stress associated with earthquakes might also be involved in generating bimodal populations of dynamically recrystallized grains. At other localities, however, there is an evolution of samples experiencing switches to lower stress deformation. The latter microstructures may be results coeval decrease of strain rate and temperature. These two contrasting deformation histories should be a focus of our future studies of megathrust systems.

Presenter biography

Djordje Grujic

Prof. Djordje Grujic is a Professor at Dalhousie University, Department of Earth Science, Canada. He is currently holding the prestigious Carnegie Chair in Geology and the Director of the UThHe (Noble Gas mass spectrometry laboratory) at his university. He has been the visiting professors at UNIL - Université de Lausanne; ETH Zurich & Stanford University. Prof. Grujic has been honoured with several awards like Jovan Zujovic medal (by University of Belgrade, Yugoslavia in 2005); Professor of the Year-2003 (by Department of Earth Sciences, Dalhousie University) and many more. He is currently the Associate Editor of Tectonics.

4. Topic: Forecasting aftershocks with the epidemic type model

Nicholas Vander Elst, USGS, USA

Abstract:

While it may never be possible to predict the exact time, place, and magnitude of an impending earthquake, it is nonetheless possible to make probabilistic assessments of aftershock hazard based on past regional sequences and the specifics of an ongoing sequence. Aftershocks follow well-established statistical rules regarding the distribution of number, time of occurrence, and magnitude. Aftershock forecasts provide situational awareness, increase public resilience, and help prioritize response and recovery operations. During times of crisis, quick production and release of these forecasts can help fill the vacuum of information and assist a variety of people in making informed decisions. In this workshop we will discuss the science behind probabilistic aftershock forecasting, and the basics of generating, communicating, and interpreting aftershock forecasts.

Presenter biography

Nicholas Vander Elst

Dr. Nicholas Vander Elstis is working as a Research Geophysicist (2018 – present) at USGS Earthquake Science Center, Pasadena, CA. He has completed PhD from University of California, Santa Cruz in the year 2012. His PhD topic was "The effect of seismic waves on earthquake nucleation and fault strength". He has been awarded with several awards like USGS Earthquake Science Center STAR award (2018); USGS Earthquake Science Center STAR award (2017); USGS Earthquake Science Center Special Thanks and Recognition (2016); UCSC Waters Award for PhD proposal (2009); ARCS Foundation Fellowship (2008); Honorable Mention, NSF Graduate Research Fellowship (2007); Chancellor's Fellowship, University of California, Santa Cruz (2006); Summer of Applied Geophysical Experience, LANL (2004); JPL Undergraduate Scholar (2002); Santa Ana College President's Scholar (2002). He is presently the Associate Editor of Bulletin of Seismological Society of America.

5. Topic: Ground, borehole and satellite observations for search of reliable earthquake precursors

Ramesh Singh, Chapman University, USA

Abstract:

Earthquakes occur at any location on the solid earth and beneath the ocean. Characteristics of the earthquakes vary from one location to other location due to contrast in the geological settings: hydrological, stress and geophysical environments. Indian subcontinent is dynamic and made of different cratons of different sizes. The epicenter of an earthquake may be on land, ocean and could be near the ocean. The stress monitoring of the Indian cratonic blocks are being monitored using Global Positioning System (GPS). In the past, efforts were made to study surface and subsurface parameters to get an early warning of an earthquake, but individual parameters did not provide much insight about an earthquake. In the present talk, use of the ground, geophysical, borehole and multi satellite sensors will be discussed in getting information about land, ocean, atmosphere, in-situ, ionosphere and meteorological parameters in the search of a reliable precursor of an impending earthquake. Further, the need and importance of an integrated approach will be discussed in the mitigation of earthquake impacts in the seismic prone areas especially in Assam which is located in a unique stress environment.

Presenter biography

Ramesh Singh

Prof. Ramesh Singh is a Professor at School of Life & Environmental Sciences, Chapman University, CA, USA as of January 2009. He was a Professor with George Mason University, Virginia, USA during 2007-2009 and Distinguished Visiting Professor (2003-2005) with the Centre of Earth Observing Space Research. He was Professor in the Department of Civil Engineering, Indian Institute of Technology Kanpur, India during 1986-2007. He is currently the Editor-in-Chief of Geometrics, Natural Hazard and Risk.

6. Topic: Coulomb stress modelling and seismicity triggering: A perspective on future seismic hazard

RBS Yadav, Kurukshetra University, India

Abstract:

The earthquake interaction is a fundamental feature of seismicity, leading to earthquake sequences, clustering and aftershocks. The interaction criterion that promises a deeper understanding of earthquake occurrence and a better description of probabilistic hazard is the Coulomb stress transfer. The closeness of failure of fault is computed using the changes in Coulomb stress sometime referred as Coulomb Failure Function (ΔCFF). It depends on the changes in both shear stress $\Delta\tau$ and normal stress $\Delta\sigma$, which can be expressed as$\Delta CFF = \Delta\tau - \mu' (\Delta\sigma - \Delta P)$. where, $\Delta\tau$ is the changes in shear stress (positive in the direction of fault slip), $\Delta\sigma$ is the changes in normal stress (positive for the compression), ΔP is the changes in pore fluid pressure of the fault (positive for the compression) and μ' is the effective coefficient of friction. A positive value of ΔCFF for a particular fault denotes movement of that fault towards failure i.e. the likelihood that it will rupture in an earthquake is increased. Since the direct measurement of stress is not possible; hence, changes in stress value can be calculated from the information about the geometry and slip of an earthquake rupture.

Coulomb stress modeling has been performed for some large earthquakes occurred in the Indian subcontinents. Theco-seismic coulomb stress changes have been computed for October 19, 1991 Uttarkashi, February 27, 1997 Pakistan, March 28, 1999 Chamoli and October 8, 2005 Kashmir earthquakes.For this purpose, a regional compressive stress field is assumed in the Himalayan Frontal Arc whose principal axis is trending in the NNE direction, which is consistent with the direction of the movement of the Indian plate. The distribution of aftershocks of these earthquakes shows that they fall in increased Coulomb stress region and their distribution might be predicted on the basis of Coulomb failure ctriteria.It has been observed that the majority of the aftershocks of the Himalayan Frontal Arc earthquakes (Uttarkashi and Chamoli) occurred in the updip edge of the fault rupture. In the case of Kashmir (2005) earthquake, the most of the aftershocks were concentrated in the lower part of the updip edge which indicates that the source of earthquakes generation in this region is deeper than the Himalayan Frontal Arc.

Co-seismic coulomb stress modeling has been also performed for some recent earthquake sequencese.g. 2007 and 2011 Talala (Gujarat), 2008 Baluchistan (Pakistan), 2011 Van (Turkey), 2015 Gorkha (Nepal) and 2016 Imphal (Manipur) earthquakes. It has been observed that the static Coulomb stress changes due to the coseismic slip of the main shock of 2007 (Mw 5.0) Talala earthquake sequence enhanced off-fault aftershockoccurrenceand supports the postulation on aftershock triggering. Post seismic coulomb stress changes due to 2007 earthquake show positive stress changes at the epicenter of the 2011 Talala erthquakeas well as locations of afteshocks reveal triggering of 2011 event and its aftershocks. During the 2008 Baluchistan (Pakistan) earthquake sequence, the static coseismic Coulomb stress changes due to the foreshock (Mw 5.3) were found to increasestress at the hypocenter of the main shock (Mw 6.4), thus promoting the failure; and cumulative coseismic Coulomb stress changes due to the foreshock and mainshockshow that the most of theaftershocks occurred in

the region of increased Coulomb stress. The estimated coseismic Coulomb stress for the 2011 Van (Turkey) eartqhuake (Mw 7.2) using the variable slip model for depth range 0–30 kmexhibits a'butterfly' pattern and the most of the aftershocks (90%) fall in the region of enhanced Coulomb stress, which suggests that aftershock activities have been triggered by transfer of positive Coulomb stressdue to coseismic slip of the mainshock.The coseismic Coulomb stress changes have been evolved on the Main Himalyan Thrust (MHT) due to 2015 Gorkha main earthquake (Mw 7.8) and its largest aftershock (Mw 7.3), and the forecasted seismicty rate during next year was modeled highter than 2.5 times than the background seismicty. Co-seismic Coulomb stress cnahges due to 2016 Imphal earthquake have been evolved on Kopili, Churachandpur Mao and Dauki faults; and observed that the Kopili and Churachandpur Mao faults received increased stress and, therefore, posses high hazard in near future, while Dauki fault did not received increased stress.

A three-dimensional (3D) co-seismic and post-seismic coulomb stress changes have been caluctaed due to 2001 Bhuj earthquake (Mw 7.7)by taking viscoelastic relaxation into account for a wide region of the KRB. The postseismic coulomb stress changes after 10 years are more prominent in NW and SE regions of the mainshock due to viscoelastic stress relaxation processes, which may be a site for occurrence of future aftershocks in these regions. It has been observed that the viscoelastic ∆CFS perturbs the stress level up to the eastern Saurashtra within shallow depth (0-10 km) that triggered seismic activity in recent time in this region. The stress evolution along the Maqin-Maqu segment (MMS)of the East Kunlun Fault zone has been also calculated during1879–2008 by integrating coseismic effects, viscoelastic relaxation and tectonic loading; and observed that, compared to coseismic staticstress changes, the post-seismic viscoelastic relaxation process has played a more importantrole on stress accumulation.

The above studies show that Coulomb stress changes help to understand the earthquake intraction processes, seismicty triggering and play an important role in assesing the future seismic hazard of any region.

Presenter biography

R B S Yadav

Dr. R.B.S. Yadav is presently working as an Assistant Professor in the Department of Geophysics, Kurukshetra University, Kurukshetra, Haryana since April 2012. Prior to the joining of Kurukshetra University, he has worked as Scientist at the Indian National Center for Ocean Information Services (INCOIS), Hyderabad during March 2010 – April 2012 and Institute of Seismological Research (ISR), Gandhinagar, Gujarat during August 2006 – March 2010. He has completed Ph.D. degree in Engineering Seismology from the Indian Institute of Technology (I.I.T.) Roorkee, Uttarakhand in 2009. Dr. Yadav has been awarded by the "Young Reseracher Award" in 2014 by the Ministry of Earth Sciences (MoES), Govt. of India in recognition of his outstanding contributions in the field of "Earth System Sciences". He has also been granted a resercah grant in 2015 under "DST Fast-Track Young Scientist Scheme" by the DST, Govt. of India. He is presently serving as Editor of "Open Journal of Earthquake Research (OJER)" published by Scientific Research Publishing, USA.

7. Topic: Earthquake Ground Motions and Damage: The Long and the Short of It

Susan E. Hough, USGS, USA

Abstract:

Seismologists have long known that shallow geological structure, for example soft shallow sediments and deep sedimentary basins, can have a profound affect on ground motions. A consideration of basic physics illustrates how soft (low-impedance) layers will amplify the level of shaking, often at particular resonance frequencies. In basins and valleys, converted surface waves give rise to amplified and prolonged shaking. This textbook understanding leads to simple methods to predict site response for practical application, including generation of ShakeMaps that show the distribution of shaking from an earthquake, and probabilistic seismic hazard maps. In my talk, I discuss recent research that illustrates how the physics of wave propagation can be more complex than the simple models. Using results from recent investigations of the 1933 Long Beach, California, 2010 Haiti, 2015 Gorkha, Nepal, and 2019 Ridgecrest, California, earthquakes, I show that ground motions and damage can be strongly influenced by complex 3-dimensional propagation in large-scale basins, topographic amplification, and pervasive nonlinear response of shallow sedimentary layers. Each of these effects can not only give rise to significant amplifications, they can contribute to an overall pattern of shaking intensities that is counter to the prediction from simple models.

Presenter biography

Susan E. Hough

Susan Elizabeth Houghis a seismologist at the United States Geological Survey in Pasadena, California. She has served as an editor and contributor for many journals and is a contributing editor to Geotimes Magazine. She is the author of five books, including Earth shaking Science (Princeton). Hough graduated from the University of California, Berkeley in 1982 and is a University of California, San Diego Alumna, earning her Ph.D. in geophysics from the Scripps Institution of Oceanography in 1987. She has served on the Board of Directors of the Seismological Society of America from 1998 to 2004 and of the Southern California Earthquake Center from 2006 to 2009. Hough has written numerous articles for mainstream publications such as the Los Angeles Times. Altogether she has published over 100 articles in peer-reviewed journals.

8. Topic: Recent Strong and Large Intraplate Earthquakes in India

J. R. Kayal, Former Deputy Director General (Geophysics), Geological Survey of India

Abstract:

Two strong (Mw 6.0-6.3) and one large (Mw 7.7) earthquakes occurred in recent years in the intraplate Stable Continental Region (SCR) of India. These are the 1993 (Mw 6.3, intensity VIII+) shallow (~7 km) SCR event in Killari area and the 1997 (Mw 6.0, intensity VIII) deeper (~35 km) Narmoda rift basin event in Jabalpur area of central India, and the 2001 (Mw 7.7) deeper (~25 km) and largest SCR event in the Kachchh rift basin in western India. The 1993 Killari event occurred in the Deccan trap cover area, no surface fault was mapped; a small trace (~1km) of surface rupture was identified at the main shock epicentre area. The other two SCR events occurred at much deeper depth in the rift basins with no surface rupture.

Relocation of the aftershocks by *homogeneous and simultaneous inversion* methods, fault plane solutions and 3-D seismic images are used to identify the seismogenic faults/source zones at depth of these earthquakes. The results suggest that fault intersections are the most likely source zones for the SCR events. Reverse faulting earthquakes in the rift basins further suggest *inversion tectonics.*The rift basins, which were formed in a tensional stress regime in the geological past by fast northward movement of the Indian plate, now experience compressional stress due collision tectonics of the Indian plate with the Eurasian plate. Local Earthquake Tomography (LET) and Differential Tomography (Tomo-DD) images are used to delineate active faults. Aftershock cross-sections and fault plane solutions, on the other hand, reveal the fault geometries. For details of these investigations, readers are referred to Kayal (2007, *Gond. Res. Mem* 10: 189-199) and Singh et al. (2016, BSSA. doi: 10.1785/ 0120150280).

Presenter biography

J. R. Kayal

Professor J. R. Kayal did his M Sc (Applied Geophysics), from the IIT-ISM, Dhanbad in 1969, and Ph D in Microearthquake Seismology from the Victoria University of Wellington, New Zealand in 1983 as a Commonwealth Scholar. After post-graduation, he joined the Oil & Natural Gas Commission (ONGC) in 1970; then joined the Geological Survey of India (GSI) in 1971. He rose to the rank of Deputy Director General (Head, Geophysics) in the GSI, and superannuated in November 2006. He has been an Emeritus Scientist at the Jadavpur University, Kolkata, adjunct and visiting Professor to various Universities / Institutes in India and abroad, guest faculty to the UNESCO and ICTP international training courses in South Asia. He is recipient of National Geoscience Award (Govt of India), Life time Decennial Award (Indian Geophy Union) & Fellow, West Bengal Sci. Tech. He has more than 140 research publications in national and international journals, author of a book on Microearthquake Seismology and Seismotectonics of South Asia, and editor of several books and special volumes on Earthquakes; he supervised more than 10 PhD scholars. He is an active researcher and student loving Professor in India and abroad.

9. Topic: Complex seismo-tectonics of northeast India

Saurabh Baruah, CSIR-NEIST, India

Abstract:

The complexity in seismotectonics of North Eastern India is well accepted. Typically, the region is wedged among particularly three distinct regional dynamics - collision boundary to the north comprising Arunachal Himalaya, the syntaxial bend towards north-eastern most corner and Indo-Myanmar subduction zone towards east. In addition, Holocene upliftment of Shillong-Mikir plateau is another critical dynamics of the region. All these tectonic domains are the source and contribute to the intense seismicity pattern of the region. As a result, the region produced two great earthquakes of 1897 and 1950 (M>8.0) and twenty numbers of large earthquakes. Seismicity of the region is mostly constrained by shallower to intermediate depth earthquakes except Indo-Myanmar region where deeper depth earthquake occur. Characteristics of these earthquakes are vivid and inferences on mechanism of these earthquake and subsequent stress regime are a critical parameter broadly evolved from regional dynamics. Consequently these are sometimes function of depth and space mostly independent of magnitude. In fact the complexity can be lucidly explained if in-depth study on stress regime in terms of space , time and depth are estimated and interpreted. Although a broad understanding of stress regime in NE-India is established however much intense investigation in this domain is required so that the differences in stress pattern may carry information about the ongoing status of geodynamics. It is really praiseworthy to note that several researchers have contributed using different tools to substantiate the tectonic model out of extensive field cum experimental work, needless to say a proper tectonic model is still awaited where the only hindrance is complexity of geodynamics. Understanding seismic behavior of the complex domain is really frustrating since there is no expression of surface rupture questioning the epicenter of these great earthquakes. Slip rate, co-seismic uplift mismatching indicate perhaps the existence of blind fault in potential source zones which poses big threat on the contrary to clearly ascertain seismic cycle scenario of the region. The topic covers mainly the seismicity pattern, its characteristics, inferences on stress embedded with some field evidences which can be the prime inputs to the seismic hazard assessment of the region. So what is next, a comprehensive and focused multi-institutional study is the imminent need to predict a valid seismotectonic model of northeastern region of India which will be the key driver to seismic hazard assessment.

Presenter biography

Dr. Saurabh Baruah is working as the Chief Scientist at CSIR-NEIST, Assam. He has decades of research experience in the field of seismology. Under his supervision dozens of PhD thesis have been supervised. Dr. Baruah is the pioneer of the foundation of the Multi Parametric Geophysical Observatory (MPGO) Tezpur for earthquake precursor studies in North East India context. He was also winter member of 18th Indian scientific expedition to Antarctica.

10. Topic: Why does seismic hazard zoning maps are uncertain and should be revised using new seismic source modelling

Mehdi Zaré, IIEES, Iran

Abstract:

This lecture is aimed to represent the important controlling factors for Seismic Hazard Anallysis and to review the Uncertainty sources. After each major earthquake, the seismic source determinations, seismicity parameters and ground motion models are expected to be modified and there are always discussions on the reliability of the seismic hazard zoning maps and a comparison between the recorded and previously assessed ground motions. This draws attention to the importance of input dataset and the level of knowledge of the seismic source parameters in the potential seismic regions (geometry and mechanical of faults, return periods, etc.).

The south Asia region are exposed to high seismic activity and are greatly influenced by the continental convergence and active crustal shortening between the African, Arabian and the Indian plates to the NE and northward with respect to the Eurasian plate. According to the regional tectonic regime of the Iranian plateau, the focal mechanism solutions of the most earthquakes are compressional, strike-slip or a combination of these two mechanisms (Fig. 1).
The GPS-derived velocity field for the zone of interaction of the Arabian, African (Nubian, Somalian), and Eurasian plates indicates counterclockwise rotation of a broad area of the Earth's surface including the Arabian plate, adjacent parts of the Zagros and central Iran, Turkey, and the Aegean/Peloponnesus relative to Eurasia at rates in the range of 20–30 mm/yr (Reilinger et al., 2006) (Fig. 2).Central Turkey (Anatolia) moves in a coherent fashion with internal deformation <2 mm/yr. The motion of Anatolia is bounded on the north by the right-lateral North Anatolian fault and on the southeast by the left-lateral East Anatolian fault. Upper bounds on fault slip rates for these faults are 24±1 mm/yr and 9±1 mm/yr, respectively. Relative to Eurasia, the southwestern Aegean-Peloponnisos moves toward the SSW at 30±2 mm/yr in a coherent fashion with low internal deformation (<2 mm/yr) (McClusky et al., 2000). The similar measurements in the Iranian continent and northern Oman performed by Vernant et al., (2004) indicate that most of the shortening is accommodated by the Makran subduction zone (19.5±2 mm/yr) and less by the Kopet-Dag (6.5±2 mm/yr). The Central Iranian Block moves consistently with internal deformation smaller than 2 mm/yr. In the western part of Iran, distributed deformation occurs among several fold and thrust belts. Between the Central Iranian Block and the Arabian Plate, the central Zagros accommodates about 7±2 mm/yr of north–south shortening. North of the Central Iranian Block, the Alborz mountain range accommodates 8±2 mm/yrof north–south compression. According to the GPS measurements by Wang et al. (2001), the southern parts of the Himalaya show northward movement (N19°-22°E) at a rate of 36 to 38 mm/yrwith respect to stable Eurasia. Bangalore in southern India has a northward velocity of 35.9±1

mm/yr. The maximum velocity (38 mm/yr) in the northern Ganges plains approximates the rate of convergence between the Indian and Eurasian plates. All these GPS analysis indicate high rates of

deformation in the Middle-East region and the Iranian Plateau, so that the region is exposed to all-round pressures caused by the collision of lateral tectonic plates.

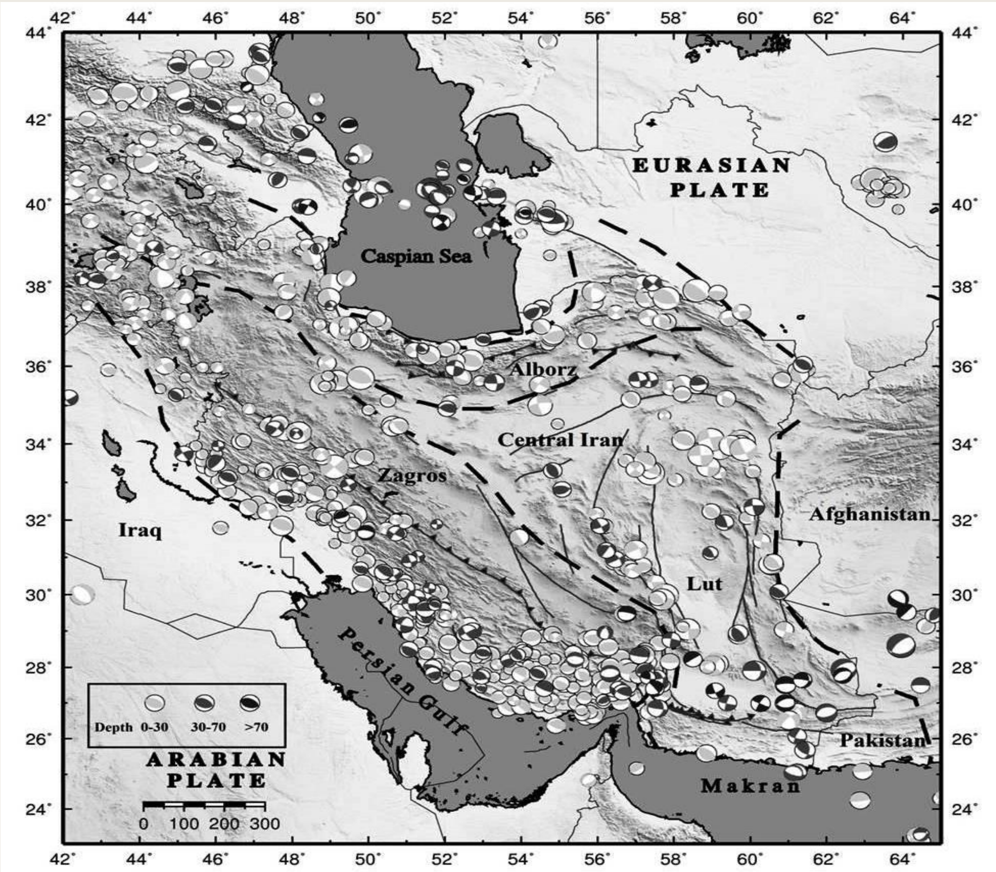

Fig 1. *Focal mechanism of the main earthquakes recorded in Iran during the last century. dashed lines: borders of the 3 main tectonic zones of Iran. solid line: major faults (adapted from Shahvar et al., 2013).*

Therefore, the geodetic, seismic and tectonic studies in the region confirm the existence of a complex active tectonic framework with high deformation rates, a part of which expresses in terms of earthquakes. This region experiences different earthquake magnitudes each year, some of them may reach M_w8 (e.g. 27 November 1945 M_w8.1 Makran earthquake). Many destructive earthquakes with magnitude≥7.0 have occurred during the last century such as the 1909 Silakhor (M_w.7.3), 1930 Salmas (M_w.7.1), 1962 Bou'in-Zahra (M_w.7.1), 1968 Dasht-e-Bayaz (M_w.7.4), 1978 Tabas (M_w.7.4), 1990 Manjil (M_w.7.4),1997 Ghaen (M_w.7.3), 2003 Bam (M_w.6.6), 2013 Savaran (M_w.7.8) earthquakes in Iran, 1939 Erzincan (M_w.7.8), 1970 Gediz (M_w.7.2), 1976 Çaldıran–Muradiye (M_w.7.0), 1999 Izmit (M_w.7.6), 1999 Düzce (M_w.7.2), 2011 Van (M_w.7.1) earthquakes in Turkey, the Nuweiba earthquake south of the Dead

Sea fault and in the Gulf of Aquaba in Egypt, the 1935 Quetta (M_w.7.7), 1945 Balochistan (M_w.8.1), 2005 Balakot (M_w.7.6), 2011 Dalbandin (M_w.7.2) and 2013 Awaran (M_w.7.7) earthquakes in Pakistan, and the 2002 Hindu-Kush (M_w.7.4) and 2015 Hindu-Kush (M_w.7.5) earthquakes in Afghanistan (Fig. 3).

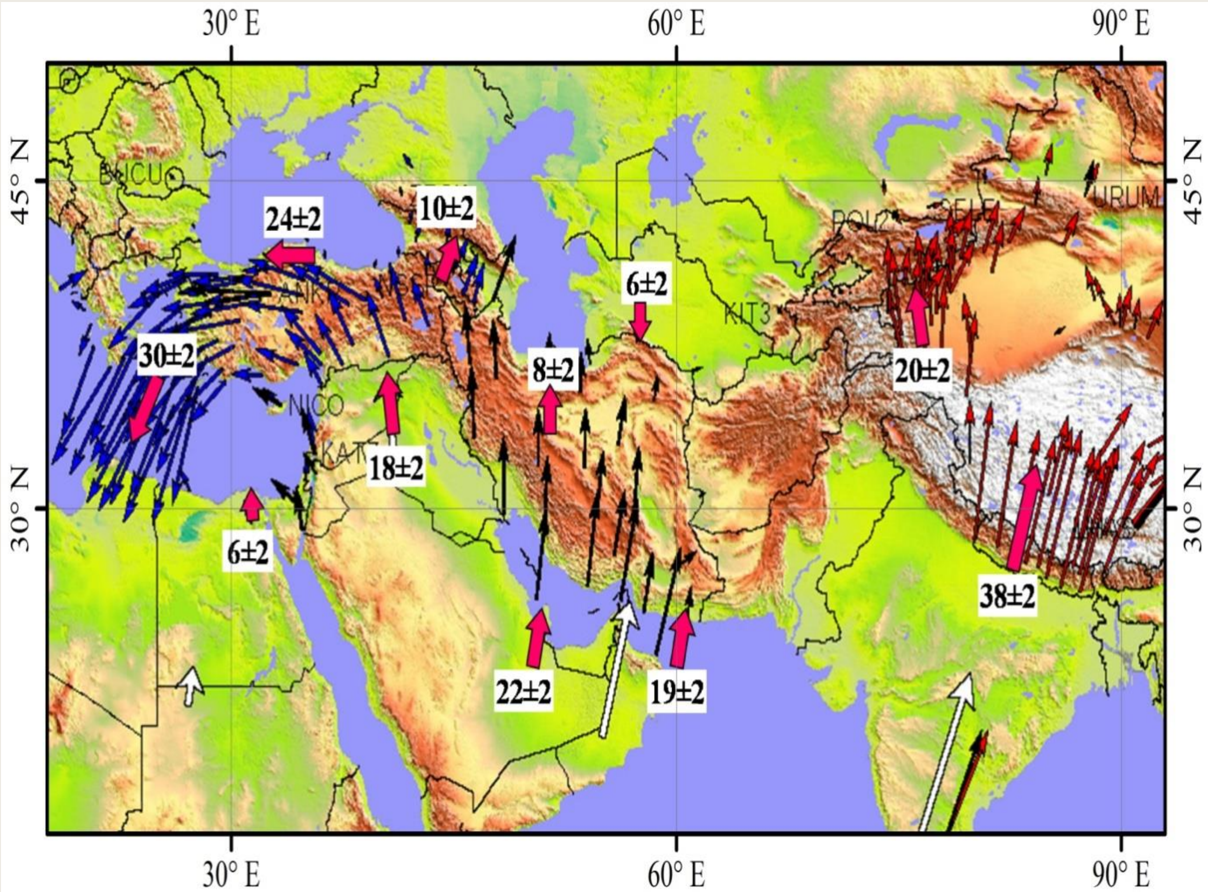

Fig 2. *Horizontal velocity field for a major part of Alpine-Himalayan chain. The blue vectors are by Reilinger et al., (2006) and McClusky et al. (2000) and the red vectors are by Wang et al. (2001). The black vectors are by Vernant et al. (2004). The white vectors are the Nuvel1-A plate velocity model by DeMets et al. (1994).*

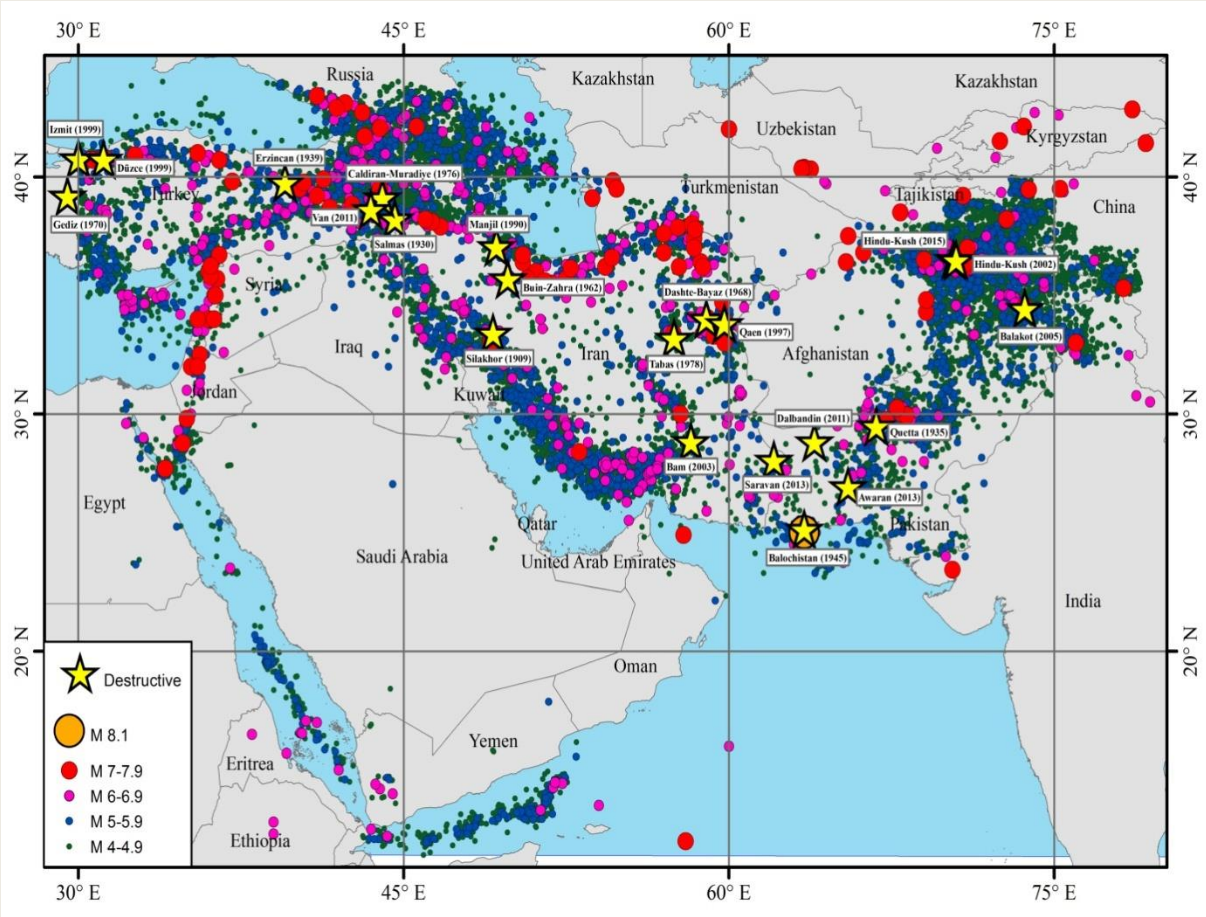

Fig. 3. *Seismicity map of the Middle East region before declustering represented by epicenters of earthquakes (4≤M_w). Yellow stars indicate some of the destructive seismic events (with 6.5≤M_w) during the last century. Source of data: EMME earthquake catalogue (Zare et al., 2014).*

After each earthquake (such as the 1990 M_w7.3 Majil earthquake and 2003 M_w6.5 Bam earthquake) some questions were raised on the reliability of the seismic hazard zoning maps and on the comparison between the recorded and previously assessed ground motions. These triggered the importance of input dataset and the level of knowledge of the seismic source parameters in the region (fault geometry and mechanics, return periods of large and destructive earthquakes, etc..).

Related efforts

The application of most popular seismic hazard analysis methods such as the Deterministic Seismic Hazard Analysis (DSHA) as well as the Probabilistic Seismic Hazard Analysis (PSHA) in this region is explained. It should be noted that reliable seismic hazard studies depend on having a robust earthquake catalogue, good knowledge on the tectonic framework and rate of active deformation, and relevant attenuation model. The better input for hazard analysis results in more reliable the parameters and the seismic hazard assessments, so that precise input data such as comprehensive catalogues, seismicity parameters as well as characteristic of seismotectonic zones lead to decrease uncertainties of the analysis. There have been several efforts to prepare uniform earthquake catalogues of the

Middle-East and Iran in the recent years such as a new earthquake catalogue of the Middle East region which has been developed consisting historical, early and modern instrumental events recorded between 1250 B.C. and 2006 (Zare et al., 2014). This effort was undertaken under the framework of Global Earthquake Model (GEM) and Earthquake Model of Middle East (EMME) projects and the final goal was to establish a unified catalogue of seismicity by incorporating regional and international data to be used for homogeneous estimation of seismic hazard in the region. I noticed that there is not enough strong-motion metadata in most parts of the study region. Uncertainties associated with the seismic hazard analysis and level of success of the Poissonian method in the region is also presented.

The trend of such seismic hazard studies in the south Asia have been initiated using deterministic approaches, continued with probabilistic approaches and finally linked to the spectral zoning maps. The trend in hazard mapping appears to cover the intensity assessment, realistic acceleration and the neo-deterministic approaches; the development of site specific seismic hazard analysis for the region should be based on the detailed integrated site characteristics database. This lecture is based on the context and a critical review of the seismic hazard studies that I performed during the last 28 years.

The Structure of the Lecture

The lecture has been organized in **7 parts** on the subjects including seismicity catalogues, strong motion processing, development of attenuation relationships and seismic hazard analysis (SHA) and etc.

In the ***part 1***, the methodology of the studies about seismicity and seismic hazard analysis is described. In this regard, the necessity of a time-dependent as compared with a time-independent seismic hazard analysis as well as the importance of Poisson distribution in the seismicity catalogues are presented briefly. It should be considered that there are not enough strong-motion metadata in the region of study, while there are relatively proper data in some parts such as Iran and Turkey. The application of most popular seismic hazard analysis approaches such as the Deterministic Seismic Hazard Analysis (DSHA) as well as the Probabilistic Seismic Hazard Analysis (PSHA) are also discussed. I also discuss uncertainties which originated from the lack of knowledge about the seismic sources and their effects on the final SHA results.

Reliable seismic hazard studies depend on having a robust earthquake catalog. The longer the extent of the catalog and the more reliable the parameters are, the better it is for those doing seismic hazard analysis. In this respect, there have been several efforts to prepare uniform earthquake catalogs of the Middle-East and Iran in the recent years which are described in the ***part 2***. In this section, the existing seismic networks within the region are first pointed out briefly. Then, the way of compiling and the reason of declustering the most important recent catalogs as the comprehensive available databanks are explained.

In the ***part 3***, I highlight the results of strong motion processing and especially the data analysis of the Iranian and Turkish strong-motion networks. The main outcome is to obtain strong motion catalogues with the seismic parameters of site conditions, the frequency band of seismic records, peak values of acceleration, velocity and displacements, source parameters (magnitude, epicentral and macroseismic distances), intensity and fault plane solutions whenever possible. The aim is to obtain with other regional dataset, a homogenous and good quality database to be incorporated in the SHA. Furthermore, the strong-motion processing of some case studies such as the earthquakes of Bam, Iran (M_w=6.5, 2003), Gorkha, Nepal (M_w=7.8, 2015) and etc are expressed and discussed.

Since the attenuation relations are one of the most essential elements of any seismic hazard analysis, in the ***part 4***, I have tried to summarize the researches, which I involved with during the last two decades for developing regional attenuation equations for Iran and other regions. In this respect, different PGA, spectral acceleration and intensity equations, with a recent development of intensity-strong motion predictive equations in Iran are described. The regional attenuation equations would lead to have less uncertainties in the seismic hazard assessments of Iran.

In the ***part 5***, I discuss the previous and current challenges in SHA studies, e.g the sufficiency of seismotectonic data in the regions of study and what we did not know about the faulting and site conditions before the major earthquakes for finalizing the seismic hazard zoning programs. Subsequently, my most important studies on seismotectonic and sources, magnitude assessments as well as the recent seismic hazard zoning in Iran, Afghanistan, Malaysia, Singapore and Iraq are summarized.

In the ***part 6***, a combination of lessons learned from in-situ earthquakes damages and subsequent phenomena observed during reconnaissance studies in different earthquake-affected areas are presented. In this regard, selected topics such as the data acquisition in earthquake recognitions, the analysis of recorded strong motions, the determination of physical damage, the near-field effects associated with directivity and fling-step, and the importance of these analysis in hazard zoning provide some insights into the seismic hazard assessment. These studies are the results of field investigations that I performed following the fourteen important recent earthquakes in Iran and other countries in the Middle East. The field studies start from the 2003 Bam (Iran) earthquake, continue with the 2003 Boumerdès-Zemmouri (Algeria), 2005 Balakot (Pakistan), 2009 Padang (Indonesia), 2009 Southeastern Tehran (Iran), 2010 Kuh-Zar (Iran), 2011 Tohoku (Japan), 2011 Van (Turkey), 2012 Varzeghan (Iran) twin events, 2013 Shonbeh (Iran), 2013 Saravan (Iran), 2013 Bashagard (Iran), 2014 Mormori (Iran) earthquakes and finally ends to the 2015 Gorkha (Nepal) earthquake. The lecture shows a process of the main observations and comparison of local SHA and scenarios between the different regions.

The lecture contains also a proposal on the regional seismic database (earthquake catalogue and strong motion database) for the South Asia region which is described the ***part 7***. One of the goals is to develop methodologies for the seismic risk evaluation and loss estimation that are tailored for different cities in the South Asia. There are some vulnerable and densely populated regions in south Asia (i.e. in India, Afghanistan, Pakistan, Nepal, etc..) where the seismic hazard and risk are high, but the quality of accessible knowledge on seismicity, seismic source parameters and strong ground motion are poorly known. This situation is not acceptable to perform a meaningful seismic hazard and risk assessment. To this end, the ground-motion models that provide hazard evaluation associated should yield accurate ground motion estimates with low dispersion through simple functional forms that use the essential geophysical and seismological information. Based on this fact, the perspective and strategy of the work plan is to develop a consistent seismicity catalogueue, strong motion dataset, detailed seismic source model and regional ground-motion models (GMMs). These need to be based on the assumption that the tectonic regimes, seismicity rates and data availability are extremely variable.

In summary, my future research plan includes the following items:

- Compilation of existing seismicity catalogues
- Reevaluating the historical earthquake catalogues
- Incorporating the new sources of information
- Assembly of strong ground-motion database
- Development of predictive model for peak ground motion and spectral values
- Evaluation of site amplification and soil linear and nonlinear behavior

Presenter biography

Mehdi Zaré

Mehdi Zare, professor of engineering seismology at the International Institute of Earthquake Engineering and Seismology (IIEES) and an associate member of the academy of sciences of Iran. He is involved in Scientific activities like Seismic Regulations for the Nuclear Power Plants, member of editorial board and founding the "Engineering Geology Group" in the Omran Magazine; Faculty of Civil Engineering, Sharif University of Technology, Tehran. Prof Mehdi Zare has decades of teaching experience and research work in the field of earthquake seismology and engineering. He has supervised dozens of PhD thesis under his guidance.

11. Topic: The Poisson Assumption: Applications in Spite of Clustering

Andrew Michael, USGS

Abstract:

The Poisson distribution is frequently used to describe the temporal behavior of earthquakes. It is the basis of Probabilistic Seismic Hazard Analysis and a frequent null hypothesis for testing earthquake prediction and forecasting methods. But the clustering of seismicity, which has been noted from our earliest earthquake records, violates the Poisson assumption that earthquakes are independent events. To get from our highly clustered data to a valid application of the Poisson distribution, we can decluster the catalog by removing foreshocks and aftershocks or transform time such that the events appear independent. In this tutorial, we will consider the uncertainties associated with these approaches; tests for determining if the Poisson distribution is a good description of the resulting data; applications to global seismicity, earthquake prediction tests, and hazards assessment; non-stationary Poisson models for Operational Earthquake Forecasting; and routes to move beyond the limitations of the Poisson assumption.

Andrew Michael

Andrew Michael has been a geophysicist with the U.S. Geological Survey's Earthquake Science Center in Menlo Park since 1986 where he combines observations of earthquake processes and statistical models to determine long-term and short-term earthquake probabilities, to evaluate proposed earthquake prediction methods, and to better understand how stress and structure function as part of the seismogenic process. A graduate of MIT (B.S., 1981) and Stanford University (M.S., 1983, Ph.D. 1986), he has authored over 100 papers and reports. He was the Editor-in-Chief of the Bulletin of the Seismological Society of America from 2004 to 2010, served on the society's Board of Directors from 2014 to 2019 and was its President from 2017 to 2018. In 2011, for that work, he received the Society's Distinguished Service award. His outreach efforts include founding the Earthquake Science Center web site (quake.usgs.gov which became part of earthquake.usgs.gov) to facilitate the rapid dissemination of earthquake information and a lecture and performance titled "The Music of Earthquakes".

12. Topic: New Seismic Design Provisions for Updated Bangladesh National Building Code (BNBC- 2017) with reference to Seismic Hazard Assessment Studies

Tahmeed M. Al-Hussaini, BUET, Bangladesh.

Abstract:

Bangladesh had its first building code in 1993, developed by a team led by Bangladesh University of Engineering and Technology (BUET), under directives issued by the Ministry of Works. The seismic risk of the country was realized through incorporation of seismic design guidelines and a seismic zoning map. Since then, major progress has been made in worldwide research in earthquake engineering and different building codes have been upgraded accordingly. BUET was again entrusted to prepare an updated building code. Subsequently in 2010, the author led efforts to revise the earthquake engineering design provisions including a new seismic zoning map for the updated Bangladesh national building code, which is now awaiting legal enactment as BNBC-2017. This presentation will address new seismic design provisions in the updated building code and with reference to the seismic zoning map will also discuss major seismic hazard assessment studies carried out for Bangladesh.

Several seismic hazard assessment studies, both probabilistic and deterministic, have been conducted for Bangladesh adopting different procedures. A very recent research publication has indicated the possibility of a mega earthquake (magnitude 8.2 to 9.0) inside Bangladesh capable of causing catastrophic consequences in major cities of Bangladesh including the capital city of Dhaka, this will also be critically discussed. Realistic seismic hazard assessment and seismic risk reduction is indeed a great challenge for Bangladesh.

Presenter biography

Tahmeed M. Al-Hussaini

Dr. Tahmeed M. Al-Hussaini, obtained his B.Sc.Engg. (civil) from BUET, Dhaka in 1984, Masters from AIT, Bangkok in 1987 and PhD from SUNY-Buffalo in 1992. He joined the faculty of BUET in 1994 and he became a professor in 2007. Dr. Al-Hussaini also served as the Director for BUET-Japan Insititute for Disaster Prevention & Urban Safety (BUET-JIDPUS) during 2013 to 2017. For more than 30 years, he has been involved in teaching, research and consultancy in geotechnical, structural and earthquake engineering in Bangladesh, USA, France, Italy and Thailand. In the US, Dr. Al-Hussaini was involved in NSF and NCEER funded research projects dealing with wave barriers for reduction of ground vibration and seismic response of base-isolated structures. He was a visiting research scientist at Ecole Centrale Paris in France during 2001 and 2002 for the European project on "Control of Vibrations from Underground Railway Traffic". Dr. Al-Hussaini undertook specialized training on Seismology and Seismic Hazard Assessment in China and Italy.

13. Topic: The challenge of computing seismic hazard maps and incorporating site effects

Sebastiano D'Amico, University of Malta, Malta

Abstract:

Seismic hazard assessment may be either probabilistic (PSHA) or deterministic (DSHA). The PSHA is a statistical approach that takes into account a long time history of seismic activity in the region around the site, a characterization of point, line or area sources of seismic activity, temporal patterns of seismicity and energy attenuation models to compute the probability of a given level of ground motion at the site occurring within a fixed time period due to a combination of potential earthquake sources. PSHA is favoured by planners in the design of seismic building codes. DSHA, on the other hand, considers a likely earthquake source scenario, and numerically computes the ground motion due to this source at a chosen remote site of interest. Both studies have their merits, and indeed a reliable appreciation of the hazard at a site requires an understanding and use of both methodologies. The talk will discuss potential challenges in determining ground motion parameters (both from a probabilistic and deterministic point of view) as well as the challenges in properly quantify the local site effects and include them in the hazard computations or ah-hoc scenarios.

Presenter biography

Sebastiano D'Amico

Sebastiano D'Amico (Ph.D.) has been working at the University of Malta, within the Department of Physics and Geosciences since 2010. He was enrolled in the Physics program of the University of Messina where he was awarded the title of "Dottore in Fisica" and holds a PhD in Geophysics from University of Naples "Federico II". In 2005 he moved to Rome where he joined the Istituto Nazionale di Geofisica e Vulcanologia (INGV). In 2007 he married Rosarianna and together with his wife he moved to U.S.A. to join the Saint Louis University (Earth and Atmospheric Sciences Department) till 2010. His research interests are in the applied aspects of geophysics and earthquake seismology. In particular, he is interested in seismicity and tectonics of the Central Mediterranean, earthquake ground motion and seismic hazard, earthquake moment tensor solutions, and ambient noise measurements on soil and buildings. In the last years, he carries also research at cultural heritage and archeological sites .and uses modern technologies, such as virtual reality and image processing, as well as geophysical teechinques to reconstruct buried structures and/or past status of the artifacts. He is the author of about 100 peer-reviewed publications.

14. Topic: Seismicity of Africa

A. A. Adepelumi, O. A. University, Nigeria

Abstract:

Earthquakes are the most terrifying and destructive amongnatural phenomena inAfrica.For many African countries, earthquake hazardconstitutes a serious threat to human life and property,sometimes causing economic losses and disruption. Theenvironmental concerns and an increased official andpublic awareness of earthquake hazards have led to a rapidrise of interest in seismicity, seismic hazard, and riskassessments in African countries.An earthquake is a vibration or disturbance of the Earth's surface caused by the abrupt release of seismic energy accumulated in underlying rocks within the Earth.

The seismicity of Africa is mainly concentrated intwo main regions - Northern and SouthAfrica. This implied that the seismotectonic process is marked by a relativemotion alternating between left and right lateralalong the African and Eurasian plate. The SouthEastern African region covers a region which isprone to a significant level of seismic hazard dueto the presence of the East African rift system.

Sub-Saharan Africa islargely a stable intra-plate region characterized by relatively low levels of seismicactivity, with earthquakes randomly distributed in spaceand time. The only parts of sub-Saharan Africa that donot display the characteristics of an intra-plate region arethe East African Rift System (EARS) and the CameroonVolcanic Line, where earthquakes are associatedwith active plate-boundary fault zones and volcanicactivity.

Seismicity in Africa is mostly associated with plate boundaries and the East AfricanRift System. Various studies have confirm that the western African rift is moreseismically active than the eastern African rift and the eastern Africa rift is most activesouth of about 3°S.

Central and West Africa, is generally considered as aseismic or having lowseismicity.The biggest magniturecorded is 6.5 in Ghana and 6 in Cameroon. The most active region is linked to MountCameroon, an active volcano. Other earthquakes of magnitude 4 to 5 are felt in the region.Regions (like Nigeria) which are classified as seismic inactive have witnessed earth tremor in the recent past.In the West African sub-region, seismic activities havebeen reported majorly in Nigeria, Ghana, and Sierra Leone. In Ghana, sparse earthquake events have occurredwithin the sixteen hundreds down to nineteenhundred, despite being situated in the southeastern marginof the West Africa craton which is far away from themajor earthquake zones (active plate boundaries). Earthquakeswere recorded in the southern part of Ghana where theAkwapim fault intersected the coastal boundary faultand the epicentres of the earthquake were related to thelevel of fault activities in these regions.Kenya has had a seismic station since 1963 as part of the World Wide Standardized Seismograph Network(WWSSN).East-Africa is well known for the East African rift system and it's connected volcanicactivity along and across both graben systems. Since a long time it is suggested that the sourceof the earthquake activity as well as the strong volcanic activity in parts of the East Africanrift is related to one or two large scale plumes originating at the core-mantle boundary(CMB). Furthermore, Uganda has been reported to be very prone to earthquakebecause it is situated between two seismicallyactive branches of the East African rift system.

The seismicity, in general, of Southern Africa is moderate, of shallow nature and in most casesdifficult to correlate with geologic features. This scatter of seismic foci is similar to the diffusepattern observed for intraplate regions around the world.Though South Africa is considered to lie in a stable continental region, earthquakes arerecorded and located daily. Large events have been recorded that resulted in severe damage.Majority of seismic events of South Africa areassociated with the deep gold mining areas.

Earthquakes have been reported in Namibia since the last century by explorers and thefirst recorded earthquake occurred in 1910. Since 1910, there have been more than 150recorded earthquakes as reported by the Council for Geoscience of South Africa (CGS), theUnited States Geological Survey (USGS), the International Seismological Centre UK and theBulawayo seismological station.The seismicity of Namibia is considered moderate with earthquakes concentratedalong the coastal escarpment and topographically high zones of the Namaqua and DamaraOrogenic belts. Other earthquakes are mainly associated with major fault systems in thecountry.The Rukwa region in the Western Highlands of Tanzania is one of the mostseismically active segments of the western branch of the East African rift system. This regioncontains evidence for past strong earthquakes as recorded in the neotectonic morphology,paleoseismic trenches and outcropping recent lacustrine deposits in the paleo-shorelines andabandoned floor of Lake Rukwa.

The North Africa region, from Egypt to Morocco, experiencedseveral damaging earthquakes in the past. Thelargest recorded seismic event reached Mw 7.3 in 1980at El Asnam in the Tell Atlas of Algeria. The occurrences of these events in the northern region were linked to its location along the Africa–Eurasia plate boundary. Also, in North Africa, Algeria is known as one of the most active region because several largeand shallow depth (0-30km) seismic events have occurred in the last six decades.

Presenter biography

A.A. Adepelumi

Prof. Adepelumi is working as a Professor at the Department of Geology, Obafemi Awolowo University, Ile-Ife, Nigeria. His research interest includes Engineering Seismology, Earthquake Monitoring, Ground Penetrating Radar, CSEM /Petrophysical studies etc. He has published more than 80 research articles in different prestigious journals.

15. Topic: Tectonics of Indo-Burmese arc.

V. K. Gahalaut, CSIR-NGRI, India

Abstract:

Earthquakes in the NE India are as diverse as the region itself. They occur in response to the India-Eurasia and India-Sunda interaction in the north and in the east, respectively. The region exhibit interplate, intraplate, intraslab and intrawedge earthquakes. It is also the region which has produced the largest continental earthquake of the Himalayan arc. Earthquakes in the Indo-Burmese arc (the Indo-Burmese wedge and Sagaing fault) occur in response to the partitioning of the India-Sunda motion along these two distinct boundaries. Under the accretionary wedge of the Indo-Burmese arc, majority of the earthquakes occur in the depth range of 30-60 km and define an eastward gently dipping seismicity trend surface that coincides with the Indian slab and are termed as intraslab earthquakes which occur on steep plane within the Indian plate. There have been recent studies which suggest that the shallower part of the wedge (below Bangladesh, Tripura and Cachar region may host a large megathrust earthquake on the plate interface. Although the earthquakes within the wedge are rare, recently there was an earthquake close to the Mizoram Myanmar border which occurred at shallow depth (<20 km) and appears to be within the wedge. In the Sagaing fault region, earthquakes occur through dextral strike slip motion along the north-south oriented plane and the stress state is consistent with the plate motion across the Sagaing fault. Beside reviewing seismicity, I plan to discuss the GPS measurements of crustal deformation and their constraints on the tectonics of the region.

Presenter biography

V. K. Gahalaut

Dr Vineet K Gahalaut received M.Tech. and Ph.D. degrees from University of Roorkee (now IIT-Roorkee) in the year 1989 and 1995, respectively. He served as Lecturer at Department of Earthquake Engineering, IIT-Roorkee (1996-1998) and Scientist at Department of Science and Technology, New Delhi (1998-1999). Currently he is a Chief Scientist at NGRI, Hyderabad. His research areas include Tectonic Geodesy and Seismology. He has established GPS networks in Andaman-Nicobar subduction zone, Indo-Burmese wedge, Garhwal-Kumaun Himalaya, Godavari failed rift region, and Koyna Warna region. He is a recipient of INSA Young Scientist award (1997), CSIR Young Scientist (2001), and MS Krishnan gold medal by IGU.

16. Topic: Earthquake hazard studies in India

Imtiaz A Parvez, CSIR-4PI, India

Abstract:

Earthquakes constitute among one of the most feared natural disasters that occur with no warning and can result in great destruction along with loss of lives, particularly seismically earthquake prone countries like India. One way to mitigate the destructive impact of such earthquakes is to conduct seismic hazard and risk assessment studies and take remedial measures. This talk aims at demonstrating significant contributions in the field of seismic zonation and microzonation studies in India and adjacent areas, which have been very valuable and beneficial not only for science but also for society. From the historical seismicity to seismic zonation and to the present scenario of seismic hazard assessment in India, whether through probabilistic or deterministic approaches, will be discussed. Strong Ground motion modeling, using a detailed knowledge of both the seismic source process and the propagation of seismic waves allows giving a high-resolution realistic description of earthquake hazard parameters. This tool permits us to define a set of earthquake scenarios and to simulate the associated synthetic signals without having to wait for a strong event to occur and that can also be applied at the regional scale, computing seismograms at the nodes of a grid with the desired spacing, or at the local scale, taking into account the source characteristics, the path and local geological and geotechnical conditions. Some results based on ground motion modeling will be discussed followed by site-specific microzonation study in few selected urban areas. The applications of such study help those earthquake and civil engineers to avail realistically estimated ground motion database for safe design of buildings and other infrastructure in the country.

Presenter biography

Imtiaz A Parvez

Dr Imtiyaz Ahmed Parvez is working in CSIR Fourth Paradigm Institute, Bangalore over the last twenty years, presently as Senior Principal Scientist. After completion of Master's degree in Geophysics and PhD in Seismology from Banaras Hindu University, Varanasi in 1995, Dr Parvez completed his Post-Doc research at the Abdus Salam-International Centre for Theoretical Physics, Trieste, Italy. Dr Parvez's seminal contributions include quantification of seismic hazard in the Indian subcontinent, in terms of expected ground motions based on rigorous source modeling and computer simulation, incisive experiment design and intensive field investigations. These resulted in the creation of the first deterministic seismic hazard map of the country and have since been greatly elaborated both in a progressive enrichment of the scientific approach and experiment based hazard quantification of specific metropolises, notably Delhi, Ahmedabad and Bangalore.

e- Abstracts from the Participants

International Virtual Workshop

On

Global Seismology & Tectonics

1. Title: Variation in earthquakes statistics with Fault geometry across scales

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Abstract:

The Gutenberg-Richter distribution is the most common feature of earthquake statistics used in the probabilistic assessment of seismic hazard. Variations in the b – value are critical in determining regional differences in predicted hazard probabilities. However simple continuum fault models produce only characteristic earthquakes.This discrepancy led to the view that regional earthquake statistics, on which probabilistic seismic hazard models are based, arise from material-heterogeneity in faults or due to interaction between multiple faults. Recently it has been suggested that if the length of linear and frictionally homogeneous faults is sufficiently large with respect to the critical earthquake nucleation dimension (L_∞), the statistics of simulated earthquakes can be similar to that of regional catalogues[1]. In particular, the b –value is found to be around 0.75 for any fault larger than about ten times its L_∞. In addition to that, b – valueis suggested to increase with an increase in the geometrical complexity of faults. I test these theoretical predictions with a new machine learned earthquake catalogue from Southern California[2]. We find that the smallest (still orders of magnitude larger than L_∞) and geometrically simplest faults systematically show a quasi-constant b – value independent of fault length. Interestingly this quasi-constant value seems remarkably close to 0.75. However, longer and geometrically more complex faults show a wide range of b – valuewith no clear trend. This leads us to question if only the shortest faults satisfy the closest of both geometrical simplicity and frictional homogeneity.b – values estimated from declustered catalogues are found to increase with increasing geometric complexity of faults.

Keywords: Gutenberg-Richter distribution; b-value; complexity index; catalogue

declustering; seismic hazard models

2. Title: The Seismological Observatory of the Colombian Northeast as a contribution to knowledge for the local management of seismic risk

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Abstract:

Seismic Risk Management is an instrument of Law 1523 of 2012, through which the processes of risk awareness, risk reduction and disaster management are executed within the framework of territorial development planning. These plans have allowed cities and communities to improve their knowledge of their own risk level, in order to adopt policies and programs to reduce or prepare for the response to the occurrence of seismic events.

The city of Bucaramanga, capital of Santander department, is located in an area of high seismic hazard according to the Colombian Building Regulations Earthquake Resistant NSR-10 and may be affected by an originating earthquake on the fault of Bucaramanga - Santa Marta, FrontalFault of the Eastern Cordillera and the activity of the Bucaramanga Seismic Nest. Due to the particular characteristics of the subsoil and the topography of the terrain, there are amplification effects of seismic waves on the surface, which added to the vulnerability in buildings that do not have earthquake resistant construction structures, can increase damage to the city, constituting a significant risk for society in general.

As a fundamental part of strengthening and generating knowledge for the Management of Seismic Risk in Santander, in 2018 the Seismological Observatory of the Colombian Northeast began activities, which becomes the first regional seismological monitoring center and its main objectives are research of the amplification and modification phenomena in the propagation of seismic waves and the generation of useful information for the Seismic Microzoning of the Bucaramanga Metropolitan Area

Keywords: earthquake, seismic monitoring, site effects, seismic risk

3. Title: Characterizing the epidemiological dynamics of Covid-19 using Deep Learning

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Abstract:

The recent worldwide pandemic caused by the recent evolved family of the severe acute respiratory syndrome coronavirus 2 (SARS-COV-2), or Covid-19 has prompted researchers to look into the range of spread and try to contain the spread of the virus. At present, the need to devise proper control measures that would stringently prevent the rampant spread is of utmost importance. In recent research methods, there have been non-parametric tests that have tried to characterize the Covid-19 time series data of the major countries and devised methods of control. In this research, we wish to proceed further from the existing research in that field by applying deep learning methods to characterize the epidemiological dynamics of this disease. In this research, there will be a forecast of the spread of the disease in the future as well. In particular, there will be the usage of Artificial Neural Networks and Convolutional Neural Networks (hyperparameters like number of layers, activation functions, etc. are decided with the help of hyperparameter tuning). Other than the above deep learning models, we will build a Long Short Term Memory (LSTM) model and CNN-LSTM Model for the forecasting. The efficiency of all the models will be compared and an analytical approach will be devised for accurate predictions and characterizations.

Keywords: COVID-19, ANN, CNN, LSTM, hyperparameters.

4. Title: Does pore-pressure induced permeability enhancement aid fluid-induced aseismic ruptures outpace pore-fluid migration?

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Abstract:

The spatio-temporal migration of fluid induced seismicity is classically connected to diffusive pore-fluid movement. However, a growing body of observations provide evidence for distant induced earthquakes at very short times since injection, which are difficult to explain with the plausible range of reported crustal diffusivities. Recent studies suggest that such anomalously fast seismicity migration might, instead, be explained by elastic-stress perturbations provided by fluid-induced, aseismic ruptures which have outpaced pore-pressure diffusion. However, on linear slip-weakening faults with constant damage-zone permeability, a 1D shear rupture can aseismically outpace the pore-pressure front only under high overpressures and when background stress is very close to the residual strength($\tau b \approx \tau r$). This parameter regime seems too narrow to be operating across the diverse geotectonic settings where such fast seismicity migration has been observed. Here, we examine if pore-pressure induced permeability enhancement could provide an additional mechanism that allows such ruptures to outpace pore-pressure diffusion under less restrictive conditions.

We model a 1D shear rupture, pressurized by a constant overpressure (Δp) source, with damage zone permeability varying exponentially with effective normal stress and fault strength represented by linear slip weakening friction.When friction is quasi-constant, we find that the shear rupture grows self-similarly with the non-linear pore-pressure diffusion. Outpacing solutions emerge at systematically smaller pre-stress to strength ratios as permeability enhancement or over-pressure to normal stress (σ) ratios increase. For more pronounced slip-weakening, permeability enhancement permits aseismic outpacing at much lower $\Delta p/\sigma$ values than for constant permeability fault zones. Aided by permeability enhancement, these ruptures outpace pore-pressure diffusion even when τb is substantially smaller than τr . Importantly, we find that the smallest value of $\tau b/\tau r$ for outpacing to occur, and the extent of outpacing at a given $\tau b/\tau r$, are both controlled by the level of permeability enhancement and $\Delta p/\sigma$. Our results, therefore, provide a theoretical framework within which faster-than-diffusion ruptures can occur over a wide range of fault hydro-mechanical properties. This, in turn, provides a clue as to why the emergence of fast growing aseismic slip might not be a surprise within a variety of geotectonic settings.

Keywords: induced seismicity, aseismic slip, permeability enhancement, non-linear diffusion, slip weakening friction

5. Title: Seismotectonics of Indo-Myanmar Range: A critical review

Laishram Sherjit Singh[1] and Double M Siangshai[2]

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2 NEHU , Shillong

Abstract

Indo Myanmar Range (IMR) is a young folded and faulted mountain range that lies in the subduction zone of Indian plate and Myanmar microplate. Whether the subduction is still active or not is debatable issue. Some researchers claim that subduction is inactive (Rao and Kumar, 1990: Rao and Kalpana 2005; Gahalaut and Kundu, 2013) and others opine that subduction is active (Satyabala,1998 ;Acharya, 2010 and Jade et al. 2007). There are also different views about the nature of the earthquakes occurred in this region. One school claims that earthquakes occur in this region is intraplate (Gahalaut and Kundu, 2013; Chen and Molnar, 1990; Guzman-Speziale and Ni, 1996) and another school claims that the present earthquakes occurs in this region is interplate (Satyabala, 1998).These earthquakes occur in different tectonic environments.Some related to strike slip faults within Indian plate and some are intermediate earthquakes which associated with the process of convergence of Indian plate and Myanmar microplate. This paper attempts a critical review about the nature of seismicity and present tectonic activities of IMR.

Keywords: IMR, Subduction zone, Intraplate, Interplate

6. Title: Numerical estimation of 2D and 3D topography effects on strong ground motion

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Abstract:

Engineering structures like buildings, bridges, hydro-power plants are continuously increasing in the hilly region to meet the demand of growing population in India and many parts of world. These structures can be subjected to non-uniform ground motion due to topography effects. There are many cases where unusual high peak ground accelerations were observed on the top of a hill and more damage were reported on hill top than the surrounding flat terrain [1,2,3]. This work presents the analysis of simulated responses of 3D conical topography models and SH- and SV-wave responses of their 2D sections excited with the vertically propagating plane wave-front. Fourth-order viscoelastic staggered-grid finite-difference programs are used for the simulation of seismic responses. The analysis reveals very large average spectral amplifications (ASA) of the order of 4.4 in the 3D case as compared to 2.00 and 1.54 for SH-wave and SV-wave responses, respectively. It has been observed that ASA increases up to 7.5 with increase in complexity of conical topography. Increase of ASA with increase in shape-ratio (height/Half width) has been observed in the 3D responses. A comparison of ASA estimated from SSR method (used in experimental study) with 3D/1D method revealed that SSR overestimates the topography effect. It has been concluded that there is need of consideration of 3D shape of topography along with their complexities for more profound seismic hazard estimation for the hilly regions.

Keywords: Finite difference modelling; 3D topography effects; Comparison of 2D and 3D effects.

7. Title: Detection of seismic quiescences before 1991 Uttarkashi (M_w 6.8) and 1999 Chamoli (M_w 6.6) earthquakes and its implications for stress change sensor.

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Abstract:

The present work proposes the statistically point-process model known as Epidemic-type aftershock sequence (ETAS) model for systematically investigating the seismic quiescences or seismic anomalies around the focal regions of large/strong earthquakes. For this propose, the model predicted the expected occurrence rates of earthquakes by estimating the model parameters from the original origin times of earthquakes using maximum likelihood method (Ogata 1992, 1999). Then the exhibited relative quiescence due to decreasing occurrence rates from the modeled ones can be identified by inspecting the abnormally downward deviated plot from the extended cumulative curve of the Residual Point Process (RPP) events. Examination of such RPP events in the whole time interval exhibits significant 2 years and 8 years of relative seismic quiescences before the strong 1991 Uttarkashi (M_W 6.8) and 1999 Chamoli (M_W 6.6) earthquakes respectively. Then, considering the optimally oriented planes of Chamoli earthquake, Coulomb stress changes (ΔCFS) of Uttarkashi earthquake have been investigated to check the increase or decrease of seismicity rates around the focal region of Chamoli earthquake. ΔCFS values of the Uttarkashi earthquake increases up to a range from 0.5 to 5 mbar near the source zone of Chamoli earthquake and these values may seemingly trigger the precursory slip of the 1999 Chamoli earthquake M_W (6.6)). On the other hand, the detected quiescence and activation relative to the predicted seismicity rate are consistent with the ΔCFS changes and these anomalies are sensitive enough to detect the slight stress change.

Keywords: Seismic quiescence, Coulomb stress changes, ETAS model, Uttarkashi earthquake, Chamoli earthquake

8. Title: Spatio-temporal variation in the frequency-magnitude distribution in Garhwal-Kumaon NW Himalaya and its seismotectonic implications

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Abstract

The region in Himalaya, between the great earthquakes of Kangra (1905) and Bihar-Nepal (1934), termed as Central Seismic Gap (CSG), is a potential zone for great earthquake. A broad band seismic network is continuously recording and monitoring the earthquake events in Garhwal and adjoining Shimla Hills region of Himachal Pradesh since 2007. The study region, Garhwal-Kumaun Himalaya (29°–31.5°N; 77°–81°E), lies in the CSG. The data analysis for more than 3500 local events (2007 to 2018) indicate that majority of earthquakes are occurring in a narrow zone, south of MCT in the magnitude range between 1.8 to 5.7 with focal depths of 12 to 25 km. The spatio temporal frequency-magnitude distribution is investigated along three seismically active zones in Garhwal-Kumaun Himalaya. The study emphasize that the source parameter of events and variation of stress level (b-value) in the region which is continuously accumulating stress, may indicates the region could be the probable source zone for energy release in terms of future great earthquake. The region continues to release energy in the form of smaller magnitude earthquakes and the epicentral location of the events indicates the vicinity of Munsiari Thrust, which is located to south of Main Central Thrust (MCT) is active. The events when plotted spatially with fractal values, reveals that the events near Chamoli region are becoming more pronounced as a cluster and showing relatively low b-value. Interestingly this is the region exhibiting fluids at depth and consequently low frictional coefficient. We have described seismotectonic characteristics of region through delineating the fault plane solutions and its possible association with the shallow depth inferred ruptured areas.

Keywords: NW Himalaya, Seismicity, Central Seismic Gap, b-value, Seismotectonic.

9. Title: Logic tree approach in probabilistic seismic hazard analysis of Saveh

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Abstract

In this paper, following a study on the seismotectonic and seismic rate in the area of interest, we define source zone model and estimate seismicity parameters in each zone utilizing Z-map software. We estimate seismic hazard using probabilistic approach and generate seismic hazard maps for 50, 475 and 2475 years return period. Spectral acceleration maps were prepared with the help of OpenQuake and QGIS software.Our findings show that using the probabilistic method, for a period of 0.2 second (approximation for two-store structures) and 2% probability of exceeding in 50 years, meaning return period of 2475 years, the maximum estimated acceleration in this area is 1.1g.

Keywords: seismic hazard analysis, Saveh, peak acceleration, zoning, seismic parameters, probabilistic seismic hazard analysis

10. Title: Generation of a homogenized earthquake catalog for North-East India and its vicinity in MATLAB

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Abstract

Earthquake catalogs are one of the fundamental input requirements for any Seismic Hazard Estimation Studies. Earthquake Catalogs contain data from various sources or agencies (ISC, NEIC, HRVD, USGS) recording seismic activities from different parts of the world and hence follow a myriad of earthquake magnitude scales. The target area for study has been considered within latitudes 20°-29°N and longitudes 89°-98°E. A catalog for the period of 1897-2020 for North East India and adjoining region has been compiled for homogenization to Moment Magnitude $M_{W,GCMT}$ in the range of 4 to 8.7. Different conversion relationships derived by various Regression procedures, have been considered owing to various factors to convert different globally accepted magnitude scales viz. Surface Wave magnitude scale (M_S) and Body Wave magnitude scale (M_b) and Local Magnitude scale (M_L), into a homogenous moment magnitude scale (M_W). A widely used programming language for numerical calculations all around the globe has been applied. This study involves development of a robust function in MATLAB that makes homogenization of a large data set of magnitudes much faster and renders the process less tedious. The code would help in preparation of a homogenous Catalog for future seismic hazard assessment studies in North-East India as well as its adjoining regions.

Keywords: Moment Magnitude, Regression procedures, homogenization, MATLAB, North-East India

11. Title: A review on the tectonic settings of Assam and its mineral resources.

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Abstract

The complex tectonic scenario of Assam together with the North Eastern Region of India is intricately linked with the movement of Indian Plate and its relationship with the tectono-chronology of the Himalayan orogeny. The Cyclic Global Geotectonic phenomenon influences to set-up the tectonic settings of this region. Relating to the whole processes, after a long history of plate movements, Assam possess a special geomorphic configuration, with different geological structures, peculiar Stratigraphy and typical physico-chemical environments leading to the formation of a place favorable for several economically beneficial mineral/material. The northward movement of Indian Plate towards the Burma and Eurasian Plates during Cretaceous (Scotese et.al, 1988); south-easterly dipping block-faulted shelf development and counter-clockwise rotation of Indian Plate (Wandery, 2004); coupling of Indian plates towards north-east due to collision with Burmese Plate during Eocene (Pivnik, et.al., 1998) are some of the significant activities indicative for gradual increase of tectonic disturbances towards Eocene to Miocene. Recent reports states that these ultimately results to the formation of basal foredeep unconformity, which separates the Oligocene passive margin Barail series from overlying Early to Middle Miocene foredeep Surma Group. All these Polly-deformational activity are well pronounced in the region and Assam - Arakan Basin is the remarkable example containing hydrocarbon deposits. Approximately 300 km. long over-thrust belt i.e. "Belt of Schuppen" of this region is believed to be formed during in Late Eocene which ultimately effected by syn-tectonic adjustment of crustal blocks during Miocene and is marked by folds, faults, thrusts etc. The sediment of this part is indicative of a deltaic depositional condition marked by coal deposits of Upper Assam. Remarkable deposits of limestone, clays, granites and decorative stones, sillimanite, kaolin, iron-ores, mica, beryl and many more are reported to be formed as a result of tectonic set-up of this region.

Keywords: Tectonic scenario, Assam – Arakan Basin, Belt of Schuppen, Mineral Resources

12. Title: Variation of strain rates in northeast India and seismic hazard potential

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Abstract

Estimation of strain rates of any region represents in-situ strain concentration and are directly connected to possible seismic hazard potentials. Published resultsof both permanent and campaign mode GPS velocity fields are used to find the strain rate variation across the northeast region of India, covering an area between 23.5-27.5^{o} Latitude and 90 - 97.5^{o}Longitude. Standard triangulation technique is used to find the strain parameters and are assigned at the center of each triangle. GPS stations are selected in such a way that none of the interior angles in a triangle is lower than ~ 30°, and the distance between anytwo stations remained ≤ 100 km. A total of 134 GPS stations are used in the study to construct392084 possible triangles for computation, however, only 798 triangles fits in the abovecriteria.Spatial variation of strain parameters, namely, the dilatational strain rate $(\dot{\delta})$ and shear strain rate $(\dot{\varepsilon}_{shear})$ exhibit that western part of the study area reveals significant extension, whereas the eastern part shows large compression. A higher stain rate of ~+500 nano strain (ns/y) is observed near Dhubri fault zone and a lower strain rate of -480ns/y is found near the Kopili fault zone. Except Dhubri fault zone, the entire northeast region shows significant compression (~-150 to -50ns/y). The eastern part of the Shillong plateau depicts lower strain rate (~ -125ns/y), which is confined between Barapani Shear zone and Kopili fault. The compression zone of Dauki fault immediate to the Kopili fault may corresponds to a locked section of the fault, i.e. potential region for the future earthquake.Paleoseismic investigation also shows that the eastern part of the Dauki fault is locked.The associated low strain rates in Kopili and Daukicould be an indication that the fault is late in its earthquake cycle with higher rupture probability. High dilatational rates on the other hand are associated with faults which recently experienced earthquake. The high strain rate observed near to the Dhubri fault zone suggests the extensional tectonic regime and may be associated to creeping of the fault, where deformation is strongly localized to the fault plane and could be related to low seismic hazard. Variation of shear strain found that Koili fault zone in northeast India, shows a maximum shear strain of ~250 ns/y, whereas, the rest of the study area shows shear strain variation of 10 to 150 ns/y and the fault zone with high shear strain rate are favourable for strike-slip faulting.

Keywords: Dilatational strain rate, shear strain, northeast India, earthquake potential, seismic hazard

13. Title: Analysis of Focal Mechanism Solutions of Shallow Focus Earthquakes and Deformation Mechanism of the Indo-Myanmar Ranges, Northeast India

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Abstract:

Evolution of a tectonic belt and development of associated structures are closely related to the movement of the lithospheric plates. Similarly, evolution of the Indo-Myanmar Ranges (IMR) is related to the Collision-Subduction processes between the Indian plate and Myanmar microplate. Analysis of superficial structural and tectonic features indicates a dextral (clockwise) shear coupling deformation mechanism of the range. In this process, the rocks of IMR have been subjected to WNW-ESE (E-W) compression and NNE-SSW (N-S) extension. As a result, the compression structures such as folds and thrust faults orient in the NNE-SSW trend while the tension features such as normal faults, tension joints and fractures trend parallel to the WNW-ESE compression direction. And the structures such as strike-slip faults, shear joints and fractures trend in the NW-SE and NE-SW quadrants with a sinistral and dextral sense of slip motions respectively.

However, focal mechanisms or fault plane solutions of earthquakes of focal depths 50Km or larger that occurs in and around the IMR reveals NNE – SSW (N-S) compression and WNW – ESE (E-W) extension of the range contradictory to that of the superficial structures. But analysis of focal mechanism solutions of shallower earthquakes (<50Km) shows E-W compression and N-S extension which is compatible to the superficial structural and tectonic features of the Indo-Myanmar Ranges. This implies that the evolution and deformation mechanism of IMR may probably be controlled by the westward push of the Myanmar Microplate in interaction with the Indian plate.

14. Title: Potential seismic hazard scenario of Shillong city, Meghalaya, estimated through Probabilistic Seismic Hazard Assessment (PSHA) Technique

Goutam Kashyap Boruah, Saurabh Baruah and Chandan Dey

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Abstract

Earthquakes generally occur without any warning and can be characterized by various direct and indirect effects unlike other rapidly occurring natural disasters and the damage is materialized in a very short time. Shillong city, Meghalaya is lies in one of the most seismically prone areas of the world, i.e. North Eastern region of India. Although, a lot of computational and instrumental approaches are being made in order to predict the occurrence of earthquake event, it has not been precisely possible till date. In this study, it is attempted to study the probable effect of earthquake in Shillong city and it vicinity by taking into account all of the possible source zones. The inputs, i.e. source characteristics, source seismicity, attenuation relationship, spectral ordinates etc, are fed into computational platform to carry out the analysis and assess the values of ground acceleration for different structural periods. The hazard curves portraying the exceedance rates of intensity levels for structural periods (0-4sec) are determined along with the corresponding Unified Hazard Spectra for fixed intensity levels (2-1216gal) and fixed return periods (50-1000years) are computed. Magnitude-Distance disaggregation also portrays that, earthquakes of Mw 7.8 and Mw 6.7 occurred at a respective distance of 79km and 105km may cause the highest level of damage compared to the other scenarios. The study portrays that PGA of 320cm/sec^2 and 400cm/sec^2 may be exceeded at least once for a structural period the of 0sec at least once in next 50 and 100 years..

15. Title: Correlation between seismic crustal anisotropy with seismogenic stress field beneath Shillong – Mikir Plateau and its vicinity of North East India

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Abstract

A systematic approach has been done towards understanding the correlation between polarization direction of crustal anisotropy with the seismogenic stress field at different locations of Shillong-Mikir Plateau and its vicinity of North East, India is attempted. The crustal anisotropic parameters were determined using ANISOMAT+ for 17 seismic stations based on our previous work. The stress field in and around each of the seismic stations are estimated by taking the nearest available focal mechanism solutions into consideration. The result of polarization directions of crustal anisotropy is consistent with the direction of maximum horizontal stress, σ_{max} in certain areas and with minimum horizontal stress, σ_{min} for other areas. The correlation helps in furnishing that one of the major mechanisms of seismic crustal anisotropy is due to the regional stress. The alignment of anisotropic rocks along with various active faults and lineaments in the study region plays a significant role in the contemporary orientation of seismic crustal anisotropy and seismogenic stress field. **Title:**

16. Title: Analysis and Interpretation of Magnetic data in and around the Kopili Fault.

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Abstract:

A geophysical survey is done in the remote North eastern part of INDIA which consists of four sites. Magnetic data is acquired using a layout of 100×80 m area using, Geometrics G-857 portable proton precession magnetometer and a GEM system GSM-19 VLF magnetometer (walking type). The magnetic method of geophysical survey is a useful technique than the expensive seismic methods. In this work, the objective is to estimate the location of the Kopili fault and study the magnetic susceptibility contrast of the targeted fault. As the fault is passing through some remotes areas so the geophysical survey is a bit challenging to conduct.Ground magnetic data is been collected by a Geometrics G-857 proton precession magnetometer. The data set is consists of 20 N-S and one E-W line acquired during the months of January and February, 2020. The real data is been processed for diurnal variation and regional distorting effects. Further these data are reduced to pole (RTP), Euler deconvlution and inversion were employed to characterised the Kopili Fault zone. The Euler deconvolution applied to the RTP data with different structural index vales interpret the dyke, sill, contact and fault structures. This magnetic survey also helps in the interpretation of the magnetic minerals that presents in the rocks in terms of magnetic susceptibility.

17. Title: Studying complex local structural pattern of the Kopili Fault Zone using an integrated approach of optical, radar and gravity satellite data

Chandan Dey ,Timangshu Chetia, & Prachurjya Borthakur

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Abstract:

Morphological study of topographic structures employing aerial photographs, satellite imageries and digital elevation models have been long applied to primarily delineate tectonic elements. Kopili Fault, regarded as the most active fault in the Assam Valley having hosted two large earthquakes, or rather fault zone has no definite surficial expression and was delineated for the first time via Landsat imagery in the mid-1980s. The fault zone conspicuous to several neotectonic features, such as oxbow lakes, rapids and falls, and course shift,is imperatively studied to understand the macro tectonic features which operates within the broad fault zone dimensionally encompassing 300 km in length and about 100 km in breadth. Lineaments in macro scale is delineated using ASTER global digital elevation model with spatial resolution of 30 m which were corroborated with emissivity and land surface temperature derived from Landsat 8. Further, EIGEN6C4 model, incorporating robust gravity information, was used after prior correlation with insitu data for calculating total horizontal derivative and analytical signal. The configuration of the macro lineaments tends to follow the NW-SE pattern, while the regions where the fault zone interacts with the tectonic domains of Indo-Burma Subduction Zone and the Main Boundary Thrust complex orientation is observed with transcurrent behavior. The Shillong and Mikir plateaus significantly control the local tectonics of central region of the Kopili Fault Zone. The southern end of the fault zone is inferred to be most active of the entire stretch.

18. Title :The multifractal detrended fluctuation analysis(MF-DFA) and anomalies in geomagnetic total field intensity prior to Mw 5.5 earthquake

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Abstract:

In the research article, we report the anomalies observed in geomagnetic total field intensity (B_{Total}) prior to Mw 5.5 Kokrajhar event. The multifractal analysis was scrutinized to reveal the underlying dynamics in the geomagnetic Total field intensity time series. The multifractal spectrum on the day when the event occurred ($T_{Event\ day}$) and its surrogate ($T_{Surrogate}$) was investigated to understand the behavior and dynamics hidden in B_{Total} time series. A significant variation in the multifractal spectrum was observed between $T_{Day\ one}$ (multifractal spectrum a day prior to the event) and $T_{Event\ day}$. It was also observed that the mulfractality of B_{Total} when the event occurred ($T_{Event\ day}$) got stronger than the multifractality of $T_{Day\ one}$ and was sourced from low values distribution. The multifractality in $T_{Day\ one}$ and $T_{Event\ day}$ time series was not from source type long range correlation or sourced from broad probability density function. The investigation also manifests some non-linear features which probably evinces the anomalies to be seismic induced. The observations are elaborately emphasized in the article. The study scrutinizes the underlying dynamics in geomagnetic field intensity time series for earthquake forecast and prediction studies.

19. Title: Spatial Heterogeneity of Kopili Fault: A statistical approach based on Morans correlogram

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Abstract

Kopili fault, bearing strike-slip kinematics, is an intraplateseismogenic zone that has sourced 242 earthquakes along the fringing regions of Bhutan and Assam and Arunachal Pradesh states of India since 1900 until 2019. All these earthquakes are observed in terms of magnitude and location to find their behavior statisticallyaccording to the relationship with their neighbours using the Univariate Local Morans I method. Based on the Morans correlogram, we have found that the earthquakes within the rectangle of 222km width and 149km long with Kopili fault as mid line have spatial autocorrelation up to the distance of 16.7km from each other. This shows that earthquakes which occurred in an area may exhibit certain corelative behavior with respect to subsequent eventsnear the previous epicentre. Therefore, in this study, we have significantly clustered the earthquakes into two groupsbased on positive and negativespatial autocorrelation. Then, we found that the earthquakes occurred in Bhutan have more tendency to be large rather than Arunachal Pradesh and Assam where these areas are more likely to have small earthquakes.

Keywords: Kopili Fault; explosion; Morans correlogram.

20. Title: Difference between North Korea's Explosion (09 Sep 2016) and Earthquakes

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Abstract:

The Comprehensive Nuclear-Test-Ban Treaty (CTBT) bans all nuclear explosions including tests. An explosion occurred in North Korea on September 9, 2016 at 00:30: 01 UTC with magnitude 5.3 (mb) according to USGS report. Waveforms by this event was detected and recoded by seismic networks in the Global Seismographic Network. Therefore, we used the IRIS DMC archives waveform (time-series) data from stations around the world. Its magnitude, seismic moment and corner frequency obtained based on the source spectrum of recordings. Besides, this event was compared with earthquakes from North Korea (Yellow Sea) in 2014 (Mw=4.9), Tabriz region in Iran in 2012 (Mw=6.3), and an earthquake from Italy in 2016 (Mw=6.2). Corner frequency, seismic moment and Mw were calculated for all tectonic events, and comparison between earthquakes and explosion in North Korea showed that the corner frequency for nuclear explosion is higher than tectonic earthquakes. Moreover, Pn/Lg spectral ratios calculated for two group events (earthquake and explosion) in North Korea. The best discrimination showed that the amplitude for Pn/Lg spectral ratios in explosion are higher than earthquakes. The Lg phase for earthquake observed stronger than nuclear explosion.

Keywords: Earthquake; explosion; spectral amplitude; North Korea.

List of e-Participants

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90	Antara Sharma	CSIR NEIST	India
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92	Anup Kumar Sutar	Ministry of Earth Sciences	India
93	Anupal Lahan	DIET, JORHAT	India
94	Anupam Gogoi	St. Anthony's College, Shillong	India
95	ANUPAM PARAMANIK	IIEST SHIBPUR	India
96	Anupol Bora	Sibsagar College , Joysagar	India
97	ANUPRIYA	Jiwaji University	INDIA
98	Anurag Bharadwaj	Jagannath Barooah College	India
99	Anurag Pritam Borbora	Dibrugarh University	India
100	Anurag Singh yadav	Banaras Hindu university	India
101	Anushka Mishra	Banaras Hindu University	India
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103	Anwesa Hazarika	Sibsagar college, Joysagar	India
104	Aparna C V	Cusat	India
105	Aparnna Priyadarshini Biswal	Banaras Hindu University	India
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108	Apurba Saikia	Darrang college	India
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111	Arijit Sahoo	Central university of Punjab	India
112	Arindom Gogoi	IIT Gandhinagar	India
113	ARJUN SP	Central University of Karnataka	India
114	Arman Boruah	Mizoram University	India
115	Arnab Phukan	SIBSAGAR COLLEGE, JOYSAGAR	INDIA
116	ARPITA BISWAS	IIT Kharagpur	India
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118	Arpita Paul	Wadia Institute of Himalayan Geology	India
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125	Arunabh Dutta	Dibrugarh University	India
126	Arunkumar K. S	MES Ponnani College	India
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128	Arvind Singh Jadon	School of Studies in Pharmaceutical Sciences, Jiwaji University	India
129	Arvind Yadav	Kurukshetra University, Kurukshetra (Haryana)	India
130	Aseng Mili	Sibsagar College, Joysagar	India
131	Ashim Gogoi	CSIR-NEIST	India
132	Ashish Bahuguna	IIT Roorkee	India
133	Ashish Jangra	Kurukshetra University	India
134	Ashish kumar	Institute of science, BANARAS HINDU UNIVERSITY	India
135	ASHISH KUMAR PARIDA	CENTRAL UNIVERSITY OF KARNATAKA	INDIA
136	Ashish Pal	Wadia Institute of Himalayan Geology, Dehradun, Uttarakhand	India
137	Ashivin K A	Cusat	India
138	Ashutosh Kumar	Kurukshetra University Kurukshetra	India
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140	Asif Alve	University of Dhaka	Bangladesh
141	Atefe Darzi	University of Iceland	Iceland
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143	Atul Kumar	Kumaun University, Nainital	India
144	Avinandan Jana	Central University of haryana	india
145	Avirup Nanda	Presidency University	India
146	Ayanninuola Olatunji Samuel	Nasarawa State University keffi, Nigeria	Nigeria
147	Ayush Joshi	Physical Research Laboratory	India
148	Ayushi Ram	IIT Kanpur	India
149	Ayyappadas C S	Christ College Autonomous	India
150	AZMIR ALI	I.G.N.O.U	India
151	B BHASKAR RAO	Andhra University	India
152	B.Kalyan Kumar	JNTUH	India
153	B.Ramngaihawma	Lunglei Government College	India
154	B.V.LAKSHMI	IIG	India
155	Baba Sahil Sarkar	Assam Down Town University	India
156	Baichitra Chandra Borah	Sibsagar College, Joysagar	India
157	Bandita shyam	Dibrugarh university	India
158	Barannya Kakaty	St Anthonys College, Shillong	India
159	Barsha Changmai	Dibrugarh University	India
160	BASANTA BAISHYA	Uttaranchal University	India
161	Basanta Kumar Mahanta	Indian institute of technology BOMBAY	India
162	BASISTHA SARANIA	Barkhetri	India

163	Basunandan Handique	Sibsagar college	India
164	Benjamin L Chhangte	Lunglei Govt' College	India
165	BENU DAS, S/O-UJJAL DAS	NORTH EAST REGIONAL INSTITUTE OF EDUCATION (NERIE), NCERT, UMIAM, SHILLONG, MEGHALAYA-793103	INDIA
166	Berkay Kalkar	Dokuz Eylül University	Turkey
167	BERNARD Iortyom Chinedu AGEMA	Bellagio International concept Limited	Nigeria
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169	Bhagyashree Paul	Jayoti Vidaya Peeth woman's university Jaipur	India
170	Bhagyashree Rajbonshi	Dibrugarh University	India
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176	BIJOY LAXMI KAKATY	DIBRUGARH UNIVERSITY	INDIA
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208	Chandrasmita Deka	Dimoria College	India
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227	DEBASHIS KONWAR	IIT KHARAGPUR	India
228	Debashis Sarmah	The Assam Kaziranga University	India
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230	Debashish Roi	Louis Berger	India
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234	Debasish Malla Buzar Baruah	Dibrugarh University	India
235	Debasish Mazumder	Sibsagar College	INDIA
236	Debasish Rajkonwar	Dibrugarh University	India
237	Debjani Choudhury	Assam University Silchar	India
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240	Debosmita Chakraborty	North Bengal University	India
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258	Diganta Kumar	Gauhati University	India
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260	Diksha sahai Srivastava	Ewing Christian college prayagraj	India
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275	Double M Siangshai	North Eastern Hill University, Shillong	India
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288	Dr. Ramesh Pudi	Department of Geology, Kumaun University	India
289	Dr. Syed Hamim Jeelani	K L University	India
290	Dr. Ved Prakash	India Meteorological Department	India
291	Dr.SHAIK KAREEMUNNISA BEGUM	ANDHRA UNIVERSITY	INDIA
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293	Easwari	forest Department	india
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300	Eti Khan Mitu	University of Barishal	Bangladesh
301	FALANA, Babatope Johnson	Others	Nigeria
302	Farha begum	Kakatiya University warangal	India
303	Farha Zaman	Dibrugarh University	India
304	Farheen begum	Osmania University Hyderabad	India
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310	G.R. Senthil Kumar	Annamalai University	India
311	Gaurab Khanal	Rajiv Gandhi University	India
312	Gaurav Hazarika	Cotton University	India
313	Gautam saini	Central university of haryana	India
314	Gayatri Sahoo	Banaras Hindu university	India
315	Geetartha Dutta	Dibrugarh University	India
316	Geetartha kakoty	Sibsagar college joysagar	India
317	Ghanshyam Tiwari	HNB Garhwal university	India
318	Girson V Vabeirona	Pachhunga University College	India
319	Gitartha Nath	Dibrugarh University	India

320	Gouranga Krishna Sonowal	ASSAM DOWN TOWN UNIVERSITY	India
321	Gourav Das	IIT KHARAGPUR	India
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323	Gowtham G	Bharathidasan university, Trichy	India
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327	H Laldintluanga	Mizoram University	India
328	Hammed Ajiboye Oyekan	University of Ilorin	Nigeria
329	HANSU KUMAR SHARMA	UNIVERSITY OF RAJASTHAN	INDIA
330	HARESH DEORI	ARUNACHAL UNIVERSITY OF STUDIES	INDIA
331	Harihar Paudyal	Tribhuvan University, Nepal	NEPAL
332	HARIPRASATH B	VANAVARAYAR INSTITUTE OF AGRICULTURE	INDIA
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335	Harjyoti Sharma	Assam Energy Institute, Sivasagar, RGIPT center,	India
336	Harpreet Kaur	Amity University	India
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338	Harshajit Borah	IIT KANPUR	India
339	Harshajit Nath	Bodoland University, Kokrajhar	India
340	Hasan al Faysal	Bangladesh University of Engineering and Technology	Bangladesh
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342	Hema Sandeep Sharma	Western University	Canada
343	Himanga choudhury	Lalit Chandra bharali college	India
344	HIMANGSHU BAISHYA	Gauhati University	India
345	HIMANGSHU KUMAR HAZARIKA	Amity university, Noida	India
346	HIRAK JYOTI CHOUDHURY	SUALKUCHI BUDRAM MADHAB SATRADHIKAR,COLLEGE	INDIA
347	Hirakjyoti Das	Nalbari College, Nalbari	India
348	HITESH CH DAS	CENTRAL UNIVERSITY OF RAJASTHAN	India
349	Hitesh medok	COTTON UNIVERSITY	India
350	Hriday Ranjan Gogoi	Assam University Diphu Campus	India
351	Hrik Chaudhury	Indian Institute of Technology , Guwahati	India
352	Ifeanyi Emmanuel Anyanwu	University of Nigeria, Nsukka	Nigeria
353	Iftiasam Yesmin	THE ASSAM ROYAL GLOBAL UNIVERSITY	India
354	Ilya Dricker	Instrumental Software technologies, Inc.	USA
355	Imtiaz A Parvez(Speaker)	CSIR-4PI	India
356	Indira Gahatraj	Assam University	India
357	Indrani Sonowal	Sibsagar College,Joysagar	India
358	IRFAN BASHA. S	Bharathidhasan University	India

359	Irmiya Samson Amoka	Kaduna Polytechnic	Nigeria
360	Isah Abdulhakim Nasir	Federal University Dutsan-Ma	Nigeria
361	Ishani	NIT Rourkela	India
362	Ishika Bhattacharya	Indian Institute of Technology (ISM) Dhanbad	India
363	Ishita Kuiti	Raja Narendralal Khan Women's Collefe(autonomous)	India
364	Ishrat Jahan Eva	University of Dhaka	Bangladesh
365	Ishrat Rahman	University of Dhaka	Bangladesh
366	ISRAEL CHERUKURI	Acharya Nagarjuna University	India
367	Izharul Hussain	Sapthagiri College of Engineering, Bangalore	India
368	J R Kayal(Speaker)	Former Dy DG, GSI	India
369	J. Malsawma	Mizoram University	India
370	JAGAMOHAN MAHANTA	Central University of Punjab	India
371	Jagat Chandra Gogoi	Mariani College, Mariani, Dist. Jorhat, Assam; PIN-785634	India
372	Jahid Rohman	Sibsagar college, joysagar	India
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375	JAMINI BORUAH	COTTON UNIVERSITY	India
376	Janifar Hakim Lupin	University of Dhaka	Bangladesh
377	Jannine T. Vasquez	University of the Philippines Resilience Institute	Philippines
378	Januka Attanayake	University of Melbourne	Australia
379	Jeremiah Modi	Saint Claret college	India
380	JESTIN JOHN	Cochin University of Science and Technology	India
381	Jimmi Debbarma	Tripura University	India
382	Jimmy Lalnunmawia	Mizoram University	India
383	JITUMANI DEKA	DR.B BOROAH CANCER INSTITUTE	INDIA
384	JOECECIL R	BHARATHIAR UNIVERSITY	INDIA
385	John Blick	Lunglei Govt' College	India
386	JONALI MEDHI	Arya Vidyapeeth College	India
387	Joses Omojola	Louisiana State University	Nigeria
388	Joshi Dutta	Royal Global University	India
389	JOYASHREE DUTTA	CSIR NEIST	India
390	Juan Carlos Graciosa	Monash University	Australia
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393	JYOTI PRATIM KALITA	ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY	INDIA
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395	Jyotima Kanaujia	Indian Institute of Geomegnatism	India
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408	Kartik Baishya	Assam engineering institute	India
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410	Kasturi Saikia	Sibsagar college, Joysagar	India
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421	Khitindra Brat Bora	Sibsagar College, Joysagar	India
422	Khundrakpam Kumarjit Singh	Manipur University	India
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429	Kishore kumar Tamuli	Guwahati University	India
430	Kishore Tamang	Diphu Campus	India
431	Km Sandhya	Banaras Hindu University	India
432	Kokkiligadda Swathi	CSIR-NGRI	INDIAN
433	Komal Rani Pasricha	Ministry of Earth Sciences	India
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443	Kuldeep Dutta	Sikkim University	India
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451	Lakshmi priya	Bharathidasan University	Indis
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453	Lal Bahadur Thapa Singjali	Tribhuvan University	Nepal
454	Lalawmpuia Tochhawng	Mizoram University	India
455	Laldinpuia	Pachhunga University College	India
456	Lalhmingsanga	Amity University , Rajasthan	India
457	Lalhmingsangi	Pachhunga University College	India
458	Lalit Saikia	University of Science and Technology, Meghalaya	India
459	Lallawmsanga	University of Mysore	India
460	Lalruatpuia Tlau	IIT(ISM) Dhanbad	INDIA
461	LALTLANKIMA	Govt.Zirtiri Residential Science College	India
462	Laltluanpuii	Mizoram University	India
463	Layana Vijayan	Bharathidasan University	India
464	LISHA BORGOHAIN	COTTON UNIVERSITY	India
465	Lissa Borthakur	Sibsagar College , Joysagar	India
466	Lokita Patle	Nit rkl	India
467	Loveday Progress Jonathan	Rivers State University.	Nigeria
468	LUV KULSHRESHTHA	DAYALBAGH EDUCATIONAL INSTITUTE, AGRA	INDIA
469	M C RAGHUCHARAN	Indian Institute of Technology, Hyderabad	India
470	M.A.Swarnaa	Presidency colege	India
471	Madhan Raj K	Central university of Karnataka	India
472	Madhusmita Mahanta	Gauhati University	India
473	Magaji Zaharadin Bashir	Nasarawa State University Keffi	Nigeria
474	MAHADEV PAUL	Gossaigaon college	Indian
475	Mahananda Sengupta	Asutosh College	India
476	Mahbubah Ahmed	Bangladesh University of Engineering and Technology	Bangladesh
477	Mahesh lamsal	Patan multiple campus	Nepal

478	Mahimaa Dash	Banaras Hindu university	India
479	Mahiuashi baruah	Assam textile institute	India
480	Maitreyi	IIT-Kharagpur	India
481	MALOBIKA BORAH	DIBRUGARH UNIVERSITY	India
482	Malsawmdawngliana	Mizoram Remote Sensing Application Center (MIRSAC)	India
483	Malsawmtluanga	Lunglei Govt College	India
484	Malsawmtluangkima Hauhnar	Mizoram University	India
485	MAMALI SAHOO	National institute of technology Rourkela	India
486	Mamidak M. Iliya	Nassarawa state University,keffi, Nassarawa state, Nigeria.	Nigeria
487	Mamun Murshed Bishal	University of Dhaka	Bangladesh
488	Mamuni Sucheeta Ekka	Indian Institute of Technology (Indian School of Mines)	India
489	Manab Boruah	SIBSAGAR COLLEGE, JOYSAGAR	India
490	Manabendra Kuiry	IIT Bombay	India
491	Manash Pratim Barghiyary	Sibsagar College, Joyasagar	India
492	Manash Pratim Gogoi	Department of Geology, Sibsagar College, Joysagar	India
493	Manash Protim Bora	Sibsagar college , joysagar	India
494	Manash Protim Boruah	Sibsagar College,joysagar	India
495	Manashita Bharali	CSIR CIMFR	India
496	Manish Gohain	Cotton University	India
497	Manish Kumar	Geological Survey of India	India
498	MANISH KUMAR GUPTA	CSIR-NEIST,JORHAT	India
499	Manisha Sandhu	Kurukshetra University	India
500	MANOHAR LAL	INDIAN INSTITUTE OF GEOMAGNETISM	INDIA
501	Manoj Dahal	Amrit Science Campus	Nepal
502	MANOJ KUMAR	Wadia Institute of Himalayan Geology	India
503	Manpreet Singh	Tezpur University	India
504	Mansi Tiwari	Assam Agricultural University	India
505	Manya Mishra	Banaras Hindu University	India
506	Marianne Rhea	St. Joseph's College of Engineering	India
507	Marmili Jidung	IGNOU	India
508	Masoud Ghamari	Bu-Ali Sina University	Iran
509	Mayank Mishra	Central University of Punjab	India
510	Mayuri Borah	IIT Roorkee	India
511	Md Minhaj Alam	Central University of Haryana	India
512	Md Omar Faruk	University Of Barishal	Bangladesh
513	Md Sabir Alam	K R Manglam University Sohna Road Gurgaon Haryana	India
514	Md Salim Akhtar	University of Delhi	India
515	MD SOHAIL KHAN	SIBSAGAR COLLEGE, JOYSAGAR	INDIA
516	Md. Al Amin	University of Dhaka	Bangladesh
517	Md. Hasnat Jaman	University of Barishal	Bangladesh

518	Md. Tahseen Ahmed	University of Barishal	Bangladesh
519	Md. Zahid Zaman	Sibsagar College, Joysagar	India
520	Megan Flanagan	EditSprings	United States
521	Megha Debnath	Sibsagar College	India
522	MEGHNAD KUIRY	CENTRAL UNIVERSITY OF JHARKHAND	INDIA
523	Mehdi Zaré(Speaker)	IIEES	Iran
524	Mehilo Apon	Nagaland University	India
525	Mehrdad	Tarbiat modares univesity	Iran
526	MERIPENI EZUNG	KOHIMA SCIENCE COLLEGE, JOTSOMA	INDIA
527	MERUJYOTI SAHA	KALIABOR COLLEGE	India
528	Michael Brudzinski	Miami University	United States
529	Michael Ojo	Obafemi Awolowo University, Nigeria	Nigeria
530	MIHIR KUMAR RAI	KURUKSHETRA UNIVERSITY, KURUKSHETRA	INDIA
531	Mimansa Hazarika	Sibsagar College, Joysagar	India
532	Minakshi Mishra	CGI	India
533	Minakshi senswa	Sivsagar college joysagar	India
534	Mirinsing Angkang	IIT Dhanbad	India
535	Mita Uthaman	Indian Institute of Technology Kharagpur	India
536	Mithila Verma	Ministry of Earth Sceinces, New Delhi	India
537	MITHUN BHATTACHARJEE	Karimganj Junior College Of Science	Indian
538	Miuweme Theresa Uzeezi	Rivers State University Portharcourt, Nigeria.	Nigeria
539	MOHAMMAD SABIR PATHAN	Geological Survey of India	India
540	Mohammad Turaki	University of Maiduguri	Nigeria
541	Mohammad Yasir Arafat	University of Kashmir	India
542	Mohammed Ahmed Jalam	Federal ministry of mines and steel development.	Nigeria
543	MOHAMMED ARAFATH M	BARATHIDASAN UNIVERSITY	India
544	Mohammed Lawal Garba	Nasarawa State University, Keffi, Nigeria	Nigeria
545	Mohammed Mustapha	Universiti Sains Malaysia	Malaysia
546	MOHAMMED SHAFEEQ B	National Centre for Polar and Ocean Research	India
547	MOHANA LAKSHMI	CSIR-NGRI	India
548	Mohd Anas	University of Delhi	India
549	Mohd Zeeshan Khan	Bundelkhand University	India
550	Mohit Mohanta	Central University of Karnataka	India
551	Mohit Pandey	Indian Institute of Technology Roorkee	India
552	MOHSIN SAYEED	Aligarh Muslim University, Aligarh	INDIA
553	Moklesur Rahman	Jessore University of Science and Technology	Bangladesh
554	Monalisa Behera	NIT Rourkela	India
555	Monika	Department of geophysics	India
556	Monika	Wadia Institute of Himalayan Geology Dehradun, India	India
557	Monika karki	Tribhuvan University	Nepal

558	Monika Rani Verma	J. C. Bose University of Science and Technology, YMCA, Faridabad, Haryana	India
559	Monika Wadhawan	National Center for Seismology, New Delhi	India
560	MONISHA BORAH	NEIMS COLLEGE OF TEACHER EDUCATION	India
561	Monisha Chetia	Dibrugarh University	India
562	Monisha Shome	Assam University Silchar	India
563	Monoranjan Kakoti	J.B.College	India
564	Moruffdeen Adedapo Adabanija	Ladoke Akintola University of Technology, Ogbomoso, Nigeria	Nigeria
565	MOSTOFA HASSAN KHANDAKAR	ASSAM DOWNTOWN UNIVERSITY,GUWAHATI	INDIA
566	Mouchumi Boruah	Assam University	India
567	Mousum Dutta	Gauhati University	India
568	Mousumi Dutta	Majuli College	India
569	Mridul K	Central University of Karnataka	India
570	Mriganka Chakrabarty	Bodoland University, Kokrajhar, Assam	India
571	MRIGENDRA NARAYAN BARMAN	CSIR NEIST JORHAT	India
572	Mrinal Kumar Dutta	Jorhat Engineering College	India
573	Ms. Roseleen Ahmed	Assam Kaziranga University	India
574	Ms. Vicky Diengdoh	St. Anthony 's College, Shillong	India
575	Muaz Bin Mahmud	University Of Dhaka	Bangladesh
576	Mudit Srivastava	Indian Institute of Technology Roorkee	India
577	Muhammad Arifur Rahman	University of Dhaka	Bangladesh
578	Muhammmad Ibrahim Wada	Ahmadu Bello University Zaria	Nigeria
579	Muhyideen Hamza	Ahmadu Bello University	Nigeria
580	Mujibur Rahman Laskar	Indira Gandhi National Open University	India
581	Mukesh gupta	Central University of haryana	India
582	Mukesh Kumar Das	Indian Institute of Technology (ISM), Dhanbad	India
583	Mukunda Madhab Borah	IIT Kharagpur	India
584	MUSA YA'U	Ahmad Bello university	Nigeria
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587	N NARASIMHA CHAKRAVARTHI	CSIR NGRI	India
588	NABAJYOTI MOLIA	CSIR-NEIST Jorhat	India
589	Nabasmita Pradhan	Sambalpur University	India
590	Nachiketa Nag	IIT ISM Dhanbad	India
591	Naga Raju	CSIR- National Geophysical Research Institute	India
592	Nagraj Podugu	Borehole Geophysics Research Laboratory (BGRL)	India
593	Nandita Paul	Presidency University	India
594	NARAYANAKUMAR	IIT Hyderabad	india
595	Narendra Kumar	Wadia Institute of Himalayan geology	India
596	NASIB KAYASTHA	DIBRUGARH UNIVERSITY	INDIA
597	Navdeep kaushik	Department of Geophysics kuk	India

598	Navgeeth Mohan T M	Manipal Academy Of Higher Education	India
599	Navid Sirous	The university of Tehran	Iran
600	Nayan moni kalita	Earthquake Hazard Studies in India	India
601	Nayanjyoti Hazarika	Crescent Academy	India
602	Nazeel Sabah	IIT ROORKEE	India
603	Nazima Ansari	Banaras Hindu University	India
604	NEEHASRI KUMAR CHOWDHURY	Gauhati University	India
605	Neeraj Kumar	Central University of Haryana	India
606	NEETASHRI BORAH	JORHAT INSTITUTE OF SCIENCE AND TECHNOLOGY.	INDIA
607	NEETU GOSWAMI	Indian Institute of Technology Roorkee India	India
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609	Nicholas Vander Elst (Speaker)	USGS	USA
610	Nilanjan Mondal	PRESIDENCY UNIVERSITY, KOLKATA	India
611	Nilkantha Bandyopadhyay	Gauhati University Institute of Science and Technology	India
612	NILMANI REGMI	PATAN MULTIPLE CAMPUS, TRIBHUVAN UNIVERSITY, KATHMANDU, NEPAL	NEPAL
613	Nilutpal Bora	Indian Institute of Technology Guwahati	India
614	Nimah Masuud Kehinde	University of Lagos	Nigeria
615	NIMIKHA GOGOI	RD JUNIOR COLLEGE, DIGBOI	India
616	Ninad sahasrabudhe	Somaiya vidyavihar	India
617	Nipa Chanda	CMRIT	India
618	Niranjan Dahal	Amrit Campus,TU,Nepal	Nepal
619	Nisha solanki	Vral AVANTI WAI GIRLS GOV COLLAGE BAREILLY	India
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621	Nishita	Kurukshetra University Kurukshetra	India
622	Nitiksha Kashyap	JORHAT INSTITUTE OF SCIENCE AND TECHNOLOGY	INDIA
623	NOOR ALOM AHMED	Brahmaputra College	india
624	Noshin Sharmili	University of Dhaka	Bangladesh
625	Nowshin Laila Nisha	University of Dhaka	Bangladesh
626	NUR ANISAH BINTI MOHAMED @ A RAHMAN	University of Malaya, Malaysia	Malaysia
627	NUR SAADAH BINTI ABD MAJID	University of Malaya	Malaysia
628	Nura Abdulmumini Yelwa	University of Malaya, Malaysia	Malaysia
629	Nusratillo Sharipov	Institute of geology, earthquake engineering and seismology national academy of sciences Tajikistan (IGEES NAST)	Tajikistan
630	Nwike Stella	Chukwuemeka Odumegwu Ojukwu University, Anambra State.	Nigeria
631	Obembe Olaniyi	University of Lagos, Akoka	Nigeria
632	Ogungbade olubukola	Olabisi onobanjo university ago iwoye ogun state Nigeria	Nigeria
633	Ojaswita Singh	Ministry of Earth Sciences	India

634	Olafisoye Emmanuel	Ladoke Akintola University of Technology Ogbomoso Oyo State	Nigeria
635	Olgert Gjuzi	Institute of Geosciences Energy Water and Environment	Albania
636	Oluwasegun Babalola	Degeconek Nigeria Limited	Nigeria
637	Oluwaseun Taiwo	Obafemi Awolowo University	Canada
638	Oluwaseyi Adeola Dasho	Dominion University Ibadan	Nigeria
639	Om Prakash Kaptan	Sikkim University	India
640	Omogboyega Olasunkanmi Bamidele	Federal University of Technology Akure	Nigeria
641	Omprakash Gupta	Indian Institute of Technology (Indian School of Mines) Dhanbad	India
642	Orajiuka Rita	Institute of Geosciences and Earth Resource Keffi Nasarawa State Nigeria.	Nigeria
643	ORINDRAM SAVAPANDIT	Sibsagar college, Joysagar	India
644	Orizen M.S. Dawngliana	Mizoram University	India
645	Oyion Bhattacharyya	Sibsagar College	India
646	P MANASA	ADIKAVI NANNAYA UNIVERSITY	INDIA
647	P Sion Kumari	CSIR NGRI	INDIA
648	P.C. Lalrindika	Mizoram University	India
649	Paban Kalita	Bodoland University, Assam	India
650	Palak Agrawal	Shri varshney college, aligarh	India
651	Pallab Dey	Presidency University, Kolkata	India
652	Pallab Kashyap	Gargaon College, Dibrugarh University	India
653	Pallabi Chakraborty	The Assam Royal Global University	India
654	Pallavi singh	Ds degree college Aligarh	India
655	Pamisun Mili	Cotton University	India
656	Pankaj kunmar Yadav	Wadia Institute of Himalayan Geology, Dehradun	India
657	PARAN DEEP CHETIA	Mizoram University	India
658	Paran Sonowal	IIT(ISM) Dhanbad	India
659	PARESH NATH SINGHA ROY	Indian Institute of Technology, Kharagpur	India
660	PARIBRITA BORDOLOI	The Assam Kaziranga University	India
661	PARISMITA SAIKIA	GAUHATI UNIVERSITY	INDIA
662	Parmar Jayeshkumar Bhomaji	Kskv kuchch university bhuj	India
663	Partha Pratim Borah	KAZIRANGA UNIVERSITY	India
664	Partha Pratim Borah	Cotton University	India
665	Paul Godswill Agbai	Obafemi Awolowo University	Nigeria
666	Pc Zaichhuanawma	Pachhunga University College	India
667	Phyo Maung Maung	Earth Observatory of Singapore (EOS)	Singapore
668	Pinki Goswami	Assam down town University	India
669	Pinki Hazarika	CSIR - National Geophysical Research Institute	India
670	Pinku Mazumdar	Assam Down Town University	India
671	Pirumoni Moran	Doomdooma College,Doomdooma	India
672	Poonam Bhadauriya	Gurukul Institute of Pharmaceutical Science and	India

		Research	
673	Poonam K.C	Amrit Campus, TU	Nepal
674	POORVI NARAYANA PITTA	IIT KANPUR	India
675	Popijul Islam	Sapatgram College	India
676	Popynazu Sultana	Assam University, Silchar	India
677	Porag Senswa	Sibsagar College, Joysagar	India
678	Porishmita Dutta	Gauhati University	India
679	Pousali Mukherjee	Department of Earth Sciences, Kyoto University	Japan
680	Prabodhani Sharma	Cotton University	India
681	Prachurjya Borthakur	Amity University NOIDA	INDIA
682	PRADYUMNYA DASTIDAR	KURUKSHETRA UNIVERSITY	India
683	Praghyalakshmi Gogoi	Dibrugarh University	India
684	Prakash Man Shrestha	Patan Multiple Campus ,TU,Nepal	Nepal
685	Prakriti Sanyal	IIT Kharagpur	India
686	Prakriti Priya bharali	Gargaon College	India
687	Pranami Goswami	Gauhati University	India
688	Pranjal Baruah	Deep Industries Limited	India
689	Pranjal Bora	J. B. College, Jorhat.	India
690	Pratikshit Baruah	Sibsagar College Joysagar	India
691	Pratyush Phukan	Sibsagar College , Joysagar	India
692	Preeti Ambadas Gurram	Modern College of Arts Science and Commerce Pune	India
693	Prem Kumar	University of Delhi	India
694	PREM KUMARI	MAHARISHI DAYANAND SARASWATI UNIVERSITY AJMER, RAJASTHAN	INDIA
695	Prerona Gogoi	Sibsagar college Joysagar	India
696	Prithwijit Chakraborti	IIT(ISM), Dhanbad	India
697	PRITI REKHA GOGOI	Dibrugarh University, Department of Applied Geology	India
698	PRITOM BARUAH	Sibsagar college	India
699	Pritom Parasar	Assam university, Silchar	India
700	Pritom Sarma	Institute of Earth Sciences, The Hebrew University of Jerusalem.	India/Israel
701	PRIYABRAT BORUAH	Gauhati University	INDIA
702	Priyakshi Borgohain	Sibsagar College, Joysagar	India
703	Priyanka Arya	Central University punjab	India
704	Priyanka Borpujari	Sikkim University	India
705	PRIYANKA DEOGHARIA	Kaziranga University	India
706	Priyanka Paul	St.Anthony's College	India
707	Priyanku Bhuyan	University of Delhi	India
708	prontop kashyop	The sibsagar college	India
709	Puja Buragohain	Gargaon College, Simaluguri	India
710	PUJA DAS	Kaliabor college of education	India
711	Pulak Biswas	IIT(ISM), Dhanbad	India
712	Pushpendra sagar	Ks kv kachchh University	India

713	Putul Rajbongshi	Guwahati College	India
714	PYLA SAIRAM ADITYA	ANDHRA UNIVERSITY	India
715	Queen Chetia	Sibsagar college,jaysagar	India
716	R B S YADAV	Kurukhetra University	India
717	R. Arun Prasath	Ministry of Earth Sciences, New Delhi	India
718	R.M.T.U Rathnayake	Geological Survey and Mines Bureau	Sri Lanka
719	R.SAKTHIVEL	BHARATHIDASAN UNIVERSITY, GEOLOGY DEPARTMENT	INDIA
720	Rafael Almeida	Yachay Tech University	Ecuador
721	Rafael Pujols Guridy	Universidad Autonoma de Santo Domingo (UASD)	Dominican Republic
722	Rafiu Babatunde BALE	University of Ilorin, Nigeria	Nigeria
723	Raghupratim Rakshit	Department of Applied Geology, Dibrugarh University	India
724	Rahul Baghel	KSKV KACHCHH UNIVERSITY	INDIA
725	Rahul Mout	Dibrugarh University	India
726	Rahul Saikia	Gauhati University	India
727	Raj Kumar Priya	Sikkim University	India
728	Rajanish Kumar	Banaras Hindu University	India
729	Rajashri Borpujari	Jorhat Institute of Science and Technology (Under Assam Science and Technology University)	India
730	Rajesh Kumar maurya	Central University of haryana	India
731	Rajesh Shrestha	Amrit Campus, Tribhuvan University	Nepal
732	Rajib Biswas	Tezpur University	India
733	Rajib Saikia	Sibsagar College, Joysagar	India
734	RAKESH DAS	GIRIJANANDA CHOWDHURY INSTITUTE OF MANAGEMENT AND TECHNOLOGY GUWAHATI	India
735	Rakesh Kumar	Louis Berger	India
736	Rakesh Kumar Sahoo	Central university of karnataka	India
737	Rakesh Sarkar	Assam University, Silchar	India
738	Rakesh Yadav	Banaras Hindu University	India
739	Ram Krishna Tiwari	Tribhuvan University, nepal	Nepal
740	Ramen Das	Geological Survey of India	India
741	RAMESH BHATTARAI	DIBRUGARH UNIVERSITY	India
742	Ramesh Singh(Speaker)	Chapman University	USA
743	Ramin Kiamehr	University of Zanjan	Iran
744	Ramish Mehdi	Aligarh Muslim University	India
745	Rani Mollik	Gargaon College	India
746	RANJEET KUMAR TIWARY	BBM KOYALANCHAL UNIVERSITY DHANBAD	India
747	Ranjeeta Kar	Arya Vidyapeeth College	India
748	Ranuj Dutta	Gargaon College	India
749	Rashi	IISER Pune	India
750	RASHMI BORGOHAIN	GARGAON COLLEGE	INDIA
751	Rashmi Lahkar	D.C.B Girls' college	India
752	Rashmi Singh	Indian Institute of Technology (ISM), Dhanbad	Indian
753	Ratnamala Diddi	Central University of Karnataka	India

754	Ravi Singh	Dolphin PG Institute of Biomedical and Natural sciences	India
755	Raza Shah Ahmedy	Osmania University	India
756	Reena solanki	Prem prakash gupta Institute of engineering	India
757	Rekkibuddin Ahmed	Sibsagar college	INDIA
758	Renit Paul	Andhra University	India
759	Reshma K S	CSIR-NGRI, Hyderabad	India
760	Rhea Dhar	North-Eastern Hill University	India
761	Richa kumari	Wadia institute of Himalayan geology	India
762	Rimpy Chetia	Birbal Sahni Institute of Palaeosciences	India
763	Ringkhang Hazowary	Others	India
764	Rinki Dey	Assam University Silchar	India
765	Ripon Dey	Lumding college	INDIA
766	Ripon Gogoi	Sibsagar College, Joysagar	India
767	Ritanuka Ghosh	Presidency University	India
768	Ritika Bashistha	Dibrugarh University	India
769	Riyan Borthakur	Sibsagar College, Joysagar.	India
770	Roger Gustavo Cruz Chablé	Universidad Juárez autónoma de Tabasco	Comalcalco Tabasco
771	Rohan Roy	Presidency University	India
772	Rohit Singh	Central Water Commission	India
773	ROKTEEM NATH	Sibsagar College	India
774	ROKTIM MOHANTA	Gauhati University	India
775	ROSELEEN AHMED	Assam Kaziranga University	India
776	Roshmi Boruah	Gauhati University	India
777	Ruby Gupta	Swami Shraddhanand College, University of Delhi	India
778	Ruhul Firdaus	Institut Teknologi Sumatera	Indonesia
779	Rupam Gogoi	Sibsagar College	India
780	RUPAM SARANIA	IISER-KOLKATA	INDIA
781	Rupanka das	Sibsagar College	India
782	RUPJYOTI DUTTA	CSIR-NEIST, JORHAT	INDIA
783	S Vishal Gupta	CSIR-Fourth Paradigm Institute-Bangalore	India
784	S. M. SANOZ AHAMED	PRESIDENCY COLLEGE	India
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787	S.Lasitha	Pondicherry Central University	India
788	S.Mufsara Shameen	Presidency college	India
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791	Sachin Kumar	CSIR-NEIST	India
792	SACHIN NARAYANRAO KHUPAT	CWPRS PUNE	INDIA
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794	Sagar Barua	Bangladesh University of Engineering and Technology	Bangladesh
795	Sagar Phadnis	Savitribai Phule University Pune	India
796	Sagar Singh B	Sahyadri science college	India
797	Saiful Islam Apu	University of Dhaka	Bangladesh
798	SAISHYAM MOHANTY	Central University Of Karnataka	India
799	Saitluanga	Pachhunga University College	India
800	Saklain Mustak Alam	The Assam Royal Global University	India
801	SALEH UDDIN AHMED	Zee institute of Creative arts	India
802	Samarpan Mahato	Presidency University Kolkata	India
803	Sambuddha Mukherjee	Geological Survey of India	India
804	Sameer Yadav	Central University of Haryana	India
805	Samira fakhraeian	University of Tehran	Iran
806	Samira fakhraeian	University of Tehran	Iran
807	Samudraneel Basu	Calcutta university	India
808	Sandeep	Dept. of Geophysics, BHU, Varanasi	India
809	Sandeep Gupta	CSIR-National Geophysical Research Institute	India
810	Sandeep Lahon	GAUHATI UNIVERSITY	India
811	Sandip Kumar Rana	IIT(ISM), Dhanbad	India
812	Sandip Rabidas	National Institute of Technology Silchar	India
813	Sane Madhuri	Osmania University	India
814	Sangita Dihingia	Assam University Diphu Campus	India
815	Sangita kar	Assam University,Silchar	India
816	Sani Kasim	Bayero University Kano	Nigeria
817	Sani Usman	Ahmadu Bello University Zaria-Kaduna	Nigeria
818	Sanjai Kumar Srivastava	Nagaland University	India
819	SANJAY KUMAR	ASSAM UNIVERSITY SILCHAR	INDIA
820	Sanjeev Kumar Bhattacharyya	Geological Survey of India	India
821	Sanjib Phukon	Sibsagar college	India
822	Sanku upadhyaya	Kskv kachchh university	India
823	Santanu Bose	Presidency University, Kolkata	India
824	Santanu Sen	Rupahi College Nagaon	India
825	Santosh	Kurukshetra University Kurukshetra	India
826	Santosh Kumar	ISR	India
827	Sarahana Pokharel	Tri Chandra Multiple College	Nepal
828	SARIT CHANDA	IIT HYDERABAD	India
829	Sarmistha Bhagawati	Gauhati University	India
830	Sarod Sankar Phukan	IGNOU	India
831	SAROJ KUMAR MONDAL	CSIR-NGRI, Hyderabad	INDIA
832	Satya Ranjan Sarmah	Dimoria College	India
833	Satyajit puhan	National institute of technology Jamshedpur	India
834	Satyajit Sonowal	Gauhati University	India
835	Satyam Aggarwal	central water commission	india

836	Saumya Soni	Dr. Harisingh Gour University, Sagar (M.P)	India
837	Saurabh Baruah(Speaker)	NEIST	INDIA
838	SAURABH SAINI	IIT Kharagpur	India
839	Saurav Gogoi	Sibsagar College, Joysagar	India
840	SAURAV PAUL	Assam University , Silchar	India
841	Sausthov Maunash Bhattacharyya	CSIR-North East Institute of Science & Technology	India
842	Sayan Roy	University of Engineering and Management Kolkata	India
843	SAYANTA GHOSH	G.B.Pant National Institute of Himalayan Environment	India
844	Sayanwita Mondal.	IIT KHARAGPUR	India
845	Sayed Mohammed Hossain	Central university of punjab	India
846	Sebastiano D'Amico(Speaker)	Malta University	Malta
847	Seema Boruah	Arya Vidyapeeth College	India
848	shabnam khan	Jagannath Barooah college jorhat assam	india
849	SHABNAM MAKRARI	NEHU	INDIA
850	Shah Nawaz Ali	Bhattadev University, Bajali	India
851	Shahista	M. S University	India
852	Shalini Gogoi	Sibsagar college,Joysagar	India
853	Shantanu borpatra gohain	Sibsagar college, Joysagar	India
854	Shantanu Pandey	Indian Institute of Geomagnetism	India
855	SHARIFULLAH AHMED	Bangladesh Unversity of Engineering and Technology (BUET)	Bangladesh
856	Shariq suhail	University of Delhi	India
857	Sharmila Neupane	Trichandra Multiple Campus, Kathmandu (graduate, Engineering Geology)	Nepal
858	Shashi Kant Sah	Banaras Hindu University	India
859	Shatavisa Chatterjee	IIT Bombay	India
860	Shila Bhattarai	Tri Chandra College	Nepal
861	Shilpi sikha Das	Birjhora Mahavidyalaya	India
862	Shilpika Saikia	Assam university	India
863	Shima Sadeghzadeh	Ozyegin University	Turkey
864	Shirish Bose	Indian Institute of Technology KHARAGPUR	India
865	SHIVALIK CHAUDHARY	Kurukshetra University	India
866	Shivam Joshi	Institute of Seismological Research	India
867	Shivani vasant kalekar	GKG college kolhapur	India
868	SHIVSHANKAR SAHU	St. John College, Dimapur	India
869	Shiwam Kumar	BHU	India
870	Shovna Aich	Gargaon college	India
871	Shraboni Dam	University of Barishal	Bangladesh
872	Shraddha Deori	Sibsagar College, Joysagar	India
873	Shubhadeep Roy	Presidency University, Kolkata	India
874	Shubham Gopal More	Deogiri College Aurangabad	India
875	Shubham kushwah	Dr. Harisingh Gour University, Sagar(M.P)	India
876	Shuvankar Das	IIT Kharagpur	India

877	Shweta Priyamvada	Don Bosco College , Tura, Meghalaya	India
878	Sibashree Sharma	North Eastern Hill University, Shillong	India
879	Sibasish Nath	Sibsagar college,joysagar	India
880	Siddha Raj Bhatt	Tribhuvan University	Nepal
881	Siddhartha Chatterjee	Louis Berger	India
882	Siddhesh Dilip Jathar	Gopal Krishna Gokhale College	India
883	Sikha Barua	Amrit Pharmacy Gmch	India
884	Sikhamoni Bora	Rain Forest Research Institute	India
885	Sikhendra Kisor De	Geological Survey of India	India
886	Sikiru Haruna Moritan	Federal University of Technology Akure	Nigeria
887	Sima Ghosh	NIT Agartala	India
888	Sinjan Roy	Presidency University	India
889	SINKI DEBNATH	College of education Morigaon	India
890	SMITA GOSWAMI	Assam Science and Technology University	India
891	Smitakshi Medhi	Gauhati university	India
892	SNIGDHA KHOUND	JORHAT ENGINEERING COLLEGE	India
893	sogand rabbani	Islamic azad university	iran
894	Sogo Oladipo	Obafemi Awolowo University, Ile-ife	Nigeria
895	SOMIRON DOLAKASHARIA	SILCHAR POLYTECHNIC	india
896	Sonia Devi	Banaras Hindu University, varanasi	India
897	Sonika Jain	Adina institute of pharmaceutical sciences sagar	India
898	Soniya t	Dbs pg college.	India
899	SOORYA P. S.	Government College Kottayam	India
900	Soumya ranjan hati	IIT BOMBAY	India
901	Sourav Dutta	RCC Institute Of Information Technology	India
902	Sowrav Saikia	National Centre for Seismology, New Delhi	India
903	Sowreh Rezaei	Pukyong National University, South Korea	Iran
904	SREEJANI CHAUDHURY	UNIVERSITY OF HYDERABAD	INDIA
905	Sreejith Prasad	Central University of Karnataka	India
906	Srijanee Bora	Dibrugarh University	India
907	Srijita Das	Jadavpur University	India
908	Srutakirti Saikia	Jagganath Barooah College,Jorhat	India
909	Stuti Borgohain	Sikkim University	India
910	Subhadeep Maji	Oil India Limited	India
911	Subhadeep Pal	University of Delhi , Department of Mathematics	India
912	Subhashree Satapathy	Khallikote autonomous college	India
913	Subhrajit Handique	Sibsagar collage, joysagor	India
914	SUBHRANIL BORAL	INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR	INDIA
915	Sufiya Khatun	Barishal University	Bangladesh
916	SUGAVANAM G	PERIYAR UNIVERSITY	INDIA
917	Sujan Raj Adhikari	western University	Canada
918	Sujit Dasgupta	Independent	India

919	Sukanya Boruah	JB College	India
920	Sulagna Mitra	IIT Kharagpur	India
921	SULEMAN KAMALDEEN OLASUNKANMI	Nigeria Maritime University Okerenkoko	Nigeria
922	SUMAN RAJ MAHANTA	LTK COLLEGE AZAD	INDIA
923	Sumiaya Amin Preota	University of Dhaka	Bangladesh
924	Sumit kumar	Central university of punjab	India
925	Sunil K. Roy	CSIR-National Geophysical Research Institute	India
926	Sunil Rohilla	MoES-BGRL	India
927	Suprio Dey	Sibsagar college,Joysagar	India
928	Suraj Gogoi	Gargaon College	India
929	SURAJ KUMAR DEY	Madhab Choudhury College, Barpeta	India
930	SURAJIT NATH	MAHAPURUSHA SRIMANTA SANKARADEVA VISWAVIDYALAYA	India
931	Surendra Nadh Somala	IIT Hyderabad	India
932	Suryakant Dalai	NIT Rourkela	India
933	Suryakanta Rout	University of Mysore	India
934	Susan E. Hough(Speaker)	USGS	USA
935	Susil A K	Presidency college, chennai	India
936	Susmit Kumar Sahu	IIITDM kancheepuram	India
937	Susmita barman	Ignou	India
938	Suvrajeet Ghosh	Sibsagar College, Joysagar	India
939	Swapnil Hazarika	Sibsagar College Joysagar	India
940	SWARNALI PAUL	University of Calcutta	India
941	Swarnendu Bhuyan	IIT Kanpur	India
942	Swastik Deshmukh	Banaras Hindu University	India
943	Syed Humayun Akhter	University of Dhaka	Bangladesh
944	TABISH KHAN	Indian institute of geomagnetism	India
945	Tahmeed M. Al-Hussaini (Speaker)	BUET	Bangladesh
946	Tahsina Alam	Bangladesh University of Engineering and Technology	Bangladesh
947	TAMBALA KONGBO THEOPHILE	Research Center in Natural sciences of Lwiro (CRSN-LWIRO)	Democratic Republic of Congo
948	TAMILARASAN K	PERIYAR UNIVERSITY	INDIA
949	Tanmoy Jyoti Bhuyan	Dibrugarh University	India
950	Tanushree Sudhir Dupare	RTMNU	India
951	Tanya Srivastava	Sikkim University	India
952	Tapash Baishya	Pragjyotish College	India
953	Tapos Kumar Goswami	Department of Applied Geology, Dibrugarh University	India
954	Tarun Kumar R Tiwari	Central University of Karnataka	India
955	TAWDIWALA TANVI VIJAYBHAI	KSKVKU	India
956	teddy kharshandi	St Edmund's College, Shillong	India
957	Temsulemba Walling	Nagaland University	India

958	TH SHYAMAL SINGHA	ASSAM UNIVERSITY, SILCHAR	India
959	Thilina Uthpala	Geological Survey & Mines Bureau	Sri Lanka
960	Thompson Chinedum Irunkwor	University of Nigeria, Nsukka	Nigeria
961	Tiasha Mitra	Jogamaya Devi College, Kolkata	India
962	TIKENDRAJIT GOGOI	Gauhati University	India
963	Tilak Das	CSIR NEIST	India
964	Tim Parker	Nanometrics	USA
965	Timangshu Chetia	CSIR-North East Institute of Science and Technology	India
966	TIRTHABASA ACHARYA	INDIAN INSTITUTE OF TECHNOLOGY, KANPUR	INDIA
967	Tracy chukwuma	Unizik	Nigeria
968	Trideep Deka	BFIT Group of Institutions, Dehradun	India
969	Trinayana Sonowal	Bahona college	India
970	Trishnamani Mohanta	Central University of Karantaka	India
971	Tusar Ranjan Mohanty	Central University of Punjab	India
972	Udaya Bahadur Thapa Kshetri	Birendra Multiple campus, TU	Nepal
973	Uddipta Mani Das	Gauhati University	India
974	Uditangshu Chakraborty	IIT Kharagpur	India
975	Ujjwala Rout	Central University of Punjab,Bathinda	Indian
976	UMA GHOSH	SIDDHINATH MAHAVIDYALAYA	INDIA
977	Umesh Kalita	Sibsagar College, Joysagar	India
978	UNMILON PAL	IIT(ISM), Dhanbad	India
979	Upakul Dutta	Dibrugarh University	India
980	Upasana Das	University of Delhi	India
981	Upendra Bhatt	Doon University Dehradun	India
982	Ushasmi Baruah	Assam Kaziranga University	India
983	Uthra Dorairajan	Dwarka Doss Goverdhan Doss Vaishnav College	India
984	Utpal Saikia	West Bengal University of Animal & Fishery Sciences	India
985	V. Jennifer Joan Wallang	Department of Geology, St. Anthony's College	India
986	V. K. Gahalau(Speaker)	NGRI	India
987	Vibhavari Pramod Patil	K B C North Maharashtra University Jalgaon	India
988	Vickey sharma	Tezpur university	India
989	VIDYUNMATHI	REVA UNIVERSITY	India
990	Vignesh PM	Bharathidasan University	India
991	VIJAY KUMAR YADAV	Banaras Hindu University, Varanasi	India
992	Vijent Bhojak	iase (deemed to be) university, sardarshahr	India
993	Vikas Kumar Dwivedi	National Institute of Technology Rourkela.	India
994	Vikram Saini	Kurukshetra university	India
995	Vinay Kumar Dwivedi	Institute of Seismological Research	India
996	Vishak Jayanth	FUGRO	India
997	Vishal	IIT Roorkee	India
998	Vishal Pandey	Banaras Hindu University	India

999	Vishal Venugopal	Kj Somaiya college of science and commerce	India
1000	Vishwa Joshi	Institute of Seismological Research	India
1001	Visrutha C	Cochin University of Science and Technology	India
1002	Vitthal Devidas Sakhare	CSIR-National Geographical Research Institute Hyderabad	India
1003	VIVEK BHOJAK	ANAND INTERNATIONAL COLLEGE OF ENGINEERING, JAIPUR	INDIA
1004	Vivek Diwakar	Ramlal anand college (university of Delhi)	India
1005	Vivek G Babu	Indian Institute of Technology (ISM), Dhanbad	India
1006	Vivek Iyer	K.J. Somaiya college of science and commerce	India
1007	Walter Mooney (Speaker)	USGS	USA
1008	Yadavally Srinu	CSIR-NGRI	India
1009	Yarakhanova Dilyara Gazymovna	Development Oil & Gas	Russia
1010	Yashaswi Doley	Assam University, Silchar	India
1011	Yashika Sharma	Miranda House, University of Delhi	India
1012	Yasmin firdus hussain	Sibsagar college .joysagar	India
1013	Yatender	Central University of Haryana	India
1014	Yazhini Aravindhan	Presidency College	India
1015	Yinusa ADEUSI Olanipekun	Yabatech	Nigeria
1016	Yogesh Kumar Gupta	Central Water Commission	India
1017	Zabiullah Ansari	Aligarh Muslim University	India
1018	Zahra Bahramian	University of Tehran	Iran
1019	Zainab Usman	Bayero University Kano	Nigeria
1020	M. Ravi Kumar	CSIR-NGRI	India
1021	Nitin Sharma	CSIR-NGRI	India
1022	Radheshyam	CSIR-NGRI	India
1023	Sanjay Kumar	CSIR-NGRI	India
1024	Kusham Sandhu	CSIR-NGRI	India
1025	K. Vijay Kumar	Indian Institute of Geomagnetism	India
1026	Raghunandan Rajbongshi	PRANAB VIDHYAPITH, BOKAJAN	India
1027	Pradip Dutta	CSIR-NEIST	India
1028	Paresh Kalita	CSIR-NEIST	India