



Indian Society of Earthquake Science

(Registered under Societies Act of 1860)

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ISSN 2320 - 6217

International Symposium "Advances in Earthquake Science" (AES - 2013) and Indo-Italian International School "Use of e-infrastructures for advanced seismic hazard assessment in Indian Subcontinent"

Institute of Seismological Research (ISR) and Indian Society of Earthquake Science (ISES) organized the 2nd International Symposium on "Advances in Earthquake Science (AES-2013)" on 1st and 2nd February 2013 and International School on "Use of e-infrastructures for advanced seismic hazard assessment in Indian Subcontinent" during February 4-7, 2013 at Institute of Seismological Research (ISR), Raisan, Gandhinagar. The Symposium was sponsored by Ministry of Earth Sciences (MoES) and Nuclear Power Corporation of India Limited (NPCIL), Government of India. The International School was organized under a project funded by Friuli Venezia Giulia Region Service for International Relations and European Integration. Both the programs were well organized and highly appreciated by delegates of different age - groups .

Around 80 oral and 20 poster papers were presented on six different themes by 8 foreign and about 150 Indian delegates in the Symposium. The themes of the symposium were Earthquake Precursors and prediction Studies, Seismic/Tsunami Hazard Assessment, Neotectonics, Real Time Seismology and Seismicity Studies, Lithospheric Structure, and Engineering Seismology. Lectures were at three levels. Senior scientists delivered key note lectures reviewing status of different themes. Experienced scientists presented cutting edge state of the art results, while young scientists presented new research. Foreign delegates were from Italy, Germany and Taiwan. Indian delegates were from different parts of the country from Uttarakhand in the northwest; Delhi and UP in the north; Assam, Arunachal Pradesh and Mizoram in the northeast, West Bengal in the east, Andhra Pradesh, Karnataka and Tamilnadu in the south and Maharashtra as well as Gujarat in the west. There were 65% young delegates. Due to overwhelming response parallel sessions had to be arranged and most ISR papers were put in poster sessions. The posters on various topics were well appreciated by all, including distinguished scientists in their respective fields. Also, healthy discussion and interaction being held between experts of their fields and young researchers helped in upbringing of the research level. The research group from University of Trieste and ICTP-SAND, Italy introduced the innovative approach of neo-deterministic and scenario based seismic hazard analysis (NDSHA and SBSHA).



Highlights of AES 2013

AES - 2013 inaugurated on 1st Feb, 2013 at 09:30 AM (IST). Function was started by inviting dignitaries on the dais, followed by Saraswati vandana and lightning of lamps. Prof. B. K. Rastogi presided over the function and Prof. V. C. Thakur made his presence as a chief guest. Prof. B. K. Rastogi delivered the welcome address, and the session chairmen informed about the themes of the symposium.

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From the President's Desk

I thank all the delegates of AES - 2013 and Indo-Italian school and ISR team for making both the events successful. To promote young researchers, certificates were given to top 4 oral and 2 poster presentations of symposium to young scientists (as 1st author) below the age of 40. Following are the recipients:

- 1) Karabi Talukdar, NGRI, Hyderabad (O, I)
- 2) Chiranjib Barman, VECC, Kolkata (O, I)
- 3) Sangeeta Sharma, NEIST, Jorhat (O, II)
- 4) K. M. Sreejith, SAC, Ahmadabad (O, II)
- 5) S. P. Prizomwala, ISR, Gandhinagar (P, I)
- 6) Kapil Mohan, ISR, Gandhinagar (P, II)



ISES announces to give JOES best paper award to young scientists below the age of 40, every two years.

NEWS / EVENTS

◆ Indian Society of Earthquake Science (ISES) calls research articles for its first issue of open e-journal "Journal of Earthquake Science (JOES)".

◆ Authours can submit manuscript before 30th April, 2013. All the instructions related to manuscript submission are available at <http://www.joes.org.in> or by email at editor.joes.org.in@gmail.com.

◆ ISES invites nominations for editorial committee members of JOES.

◆ Journal of Indian geophysical Union has become a cited journal w.e.f January, 2013.

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Thereafter, abstract volume was released by Chief Guest and Guest of Honor. Dr. A. Peresan from University of Trieste, Italy was Guest of Honor. Dr. B. R. Arora, Dr. J. R. Kayal, Dr. M. Ravi Kumar, and Dr. S. Chopra grace the event as conveners of different themes of AES - 2013. Shri Jaydeep Divedi was also present on the dais as a representative of the Department of Science and Technology, Govt. of Gujarat.

Remarks by the delegates at the closing ceremony

Arun Bapat, former Addl. Director CWPRS, Pune has suggested the Total Electron Content (TEC) and Outgoing Long-Wave radiation (OLR) methods for studying earthquake precursors. **Dr. Debasis Ghose**, formerly with Variable Energy Cyclotron Center and Saha Institute of Nuclear Physics, Kolkata urged for formation of a forum where sharing of knowledge and data can happen regarding earthquake precursor studies especially dealing with geochemical precursor studies. In the reply, **DG, ISR** informed that several efforts have been made in this regard. He suggested that a working group in earthquake precursor studies will be made under ISES which can meet twice a year and hold regular workshops with the assistance from MoES/DST. **Mr. U P Singh**, NPCIL, Mumbai opined that a comprehensive homogenized catalog for the Indian region is needed for PSHA analysis. He also stressed a need to revise the IS codes for design spectra for soil and rocks. He also opined that ground motion attenuation relationships for the Indian region should be developed by incorporating all the available data sets.



Comments by Theme conveners in the Concluding Session

Dr. V.C. Thakur, convener of Neo-tectonics opined that active fault map for the whole India is required which will help in assessing the seismic hazard of a particular region and to involve Earthquake Engineers for giving final hazard map. He also said that there is a need to form a working group on active faults.

Dr. B.R. Arora, convener of Precursory studies feels that in the symposium a lot of optimism is seen in the young researchers and which is very encouraging



Participants of 2nd International Symposium Advances in Earthquake Sciences 2013

for the science. He opined that the presentations in the earthquake precursor session showed more physics which is a positive sign. He also stressed that at present the precursory research is more like a post mortem and we should move to near real time analysis and assessment of the data set.

Dr. A. Peresan, convener of Hazard Studies and Engg. Seismology mentioned that the ISR has generated and maintained the high quality data in amazing amount, and different types of analysis have been carried out, which will lead to new important findings. She opined discussions/association with experts from other countries are required for assessing optimum hazard in view of new developments in the field. She also mentioned, India as a good place to carry out new research and check/validate new models, and going back with positive feeling.

Dr. J.R. Kayal, convener of Real-Time Seismology and Seismicity complimented the ISR for organizing symposium on annual basis and mentioned that this will help in disseminating new ideas/research and will certainly help young scientists/researchers. He was very happy to see the presentations on online data analysis and different types of analyses with state of the art methods. Also, he was fascinated by seeing the results from Antarctica which were presented in the symposium.

Dr. Ravi Kumar, convener of Crustal Structure feels extremely happy on attending the symposium and heartened by seeing new and interesting results presented by young scientists. He also, mentioned about the interactive discussion after each talk, which necessitated the session chairmen to reduce the presentation time and increase the discussion time. He opined that the pres-

ent research is more tool based. It should be more process based. He stressed a need for a regional crustal model of India as lots of tomographic studies are carried out by various researchers which can be used to develop regional model. It needs to be prepared as it will be useful for hazard modeling also.

Remarks by Dr. B. K. Rastogi

As the delegates have expressed need for forums for frequent in-depth discussions and collaboration on various aspects it is proposed to form Working Groups on various aspects under the aegis of ISES as follows:

- ◆ Earthquake Precursors
- ◆ Active Faults
- ◆ Crustal Deformation
- ◆ Seismic Microzonation and Seismic Hazard
- ◆ Observational Seismology
- ◆ Physical Seismology: Physics of Earthquake Process and Structure of the Earth

ISES/ ISR will propose holding of workshops on these topics every two or three months or so for funding from MoES/ DST New Delhi.

Besides the academic sessions of symposium, kite flying, and traditional dances of Gujarat, Garbha and Dandiya, were organised for all the delegates of AES and school on Sunday, 3rd Feb 2013 in the ISR campus. Sight-seeing tours for Sabarmati Ashram, Science City and Akshardham temple were also arranged.

Indo-Italian International School on "Use of e-infrastructures for advanced seismic hazard assessment in Indian Subcontinent"

Operational issues are a pressing concern in seismic hazard assessment, as fatally evidenced by the most destructive recent events worldwide, including the Tohoku (2011) and Haiti (2010) earthquakes. Nowadays it is well recognized by the engineering community that standard hazard indicator estimates (i.e. the peak seismic ground acceleration) alone are not sufficient for the adequate design, mainly for special buildings and infrastructures. Moreover, for the protection of cultural heritage and the design of strategic buildings and critical infrastructures, when it is necessary to consider extremely long time intervals, the standard probabilistic estimates of seismic hazard (PSHA) are quite problematic, because it extrapolates ground motion with an infinitely long return period from a few hundred years of the available earthquake catalogues.

To address the above mentioned problems, during the period 4 – 7 February, 2013 the International School was organized at Institute of Seismological Research (ISR), Gandhinagar, Gujarat. The aim of the School is to train Indian geophysicists and engineers on the application of an innovative methodology that permits to evaluate the hazard from earthquakes and tsunamis, based on the physical modeling of ground shaking from a wide set of possible earthquakes. The use of this NDSHA (neo-deterministic seismic hazard assessment) approach requires a large amount of computational resources that are easily available nowadays. Recently the NDSHA method has been enabled on different computational platforms, ranging from GRID computing infrastructures to HPC dedicated cluster up to Cloud computing.

The International School was attended by around 50 participants, with an Indo-Italian faculty comprising experts in the fields of seismic hazard assessment and advanced computations. A brief review of the seismological methodologies and different kinds of e-infrastructures currently available to solve the seismological computationally intensive problems has been provided during the school, discussing advantages and drawbacks for each of them when they are used for the computational needs of seismic hazard.

The School was organized in the framework of a bilateral cooperation Project, funded by the Friuli Venezia Giulia Region (Italy), which involves ISR and CSIR-CMMACS on the Indian side and University of Trieste, ICTP and CNR-IOM on the Italian side. The project aims at developing an integrated



Indo-Italian International School Participants

system, with high scientific and technological content, for the definition of scenarios of ground shaking, that may provide local authorities and engineers advanced information for seismic and tsunami risk mitigation in the Gujarat region. Within such a project, the computational group is in charge to provide an innovative and unique approach that can enhance the capability to effectively compute realistic scenarios of seismic ground motion by means of an intensive usage of existing Indo-European e-infrastructures and of all the computational infrastructures available.

The overall goal of the collaboration is to provide a tool that easily enables scientists to compute a wide set of synthetic seismograms, dealing efficiently with variety and complexity of the potential earthquake sources, and the implementation of parametric studies to characterize the related uncertainties. The proposed methodology naturally supplies realistic time series of ground motion, which represent also reliable estimates of ground displacement readily applicable to seismic design and isolation techniques, useful to preserve historical monuments and relevant man-made structures.

Upper mantle radial anisotropy beneath the Bay of Bengal through inversion of interstation phase velocities of surface waves: S.N. Bhattacharya, Visiting scientist, Indian Institute of Science Education & Research—Kolkata

The Bay of Bengal evolved along the eastern margin of the Indian subcontinent about 130 Ma with the breakup of India from eastern Gondwanaland. Since then the Indian lithospheric plate has moved northward, along with the Bay of Bengal, and eventually collided with the Eurasian plate. The age of the lithosphere beneath the central Bay of Bengal is ~110 Ma. In the present study, shear wave velocity structure of the upper mantle beneath the Bay evaluated through inversion of phase velocities of fundamental mode Rayleigh and Love waves along two wavepaths: (i) between PBA (Port Blair) and VIS (Visakhapatnam) and (ii) between DGPR (Diglipur) and VIS (Figure 1). The seismological observatories PBA and DGPR are located on the Andaman Island and to the east of the Bay and the observatory at VIS is located on the eastern coast of India to the west of the Bay. The observatories at these stations are operated by India Meteorological Department and are equipped with broadband triaxial seismometer (Trillium 240) connected to 24 bit recorder with GPS time synchronization. The velocity response of the system is flat from 1/35 to 240 sec. The broadband earthquake records are considered which lie along the great circle are joining each pair of observatories. By cross correlating records of the pair of stations, phase velocities between 20 and 240 s periods for Rayleigh waves and between 23 and 170 s for Love waves are computed (Figure 2). These phase velocities are then inverted to find the S-wave velocity structure of the upper mantle down to 400 km (Figure 3).

The crustal structure is based on previous studies of the Bay and kept fixed during the inversion. Through nonlinear inversion, radially anisotropic upper mantle structure is obtained, where the SH-wave velocity (V_{SH}) is greater than the SV-wave velocity (V_{SV}) down to 400 km (Figure 3). The S-wave velocity decreases sharply by ~ 4.5 per cent for V_{SV} and ~1.5 per cent for V_{SH} at a depth 110 km, which is considered as the Lithosphere-Asthenosphere boundary (LAB) i.e. the bottom of the mantle lid. Based on recent studies, such sharp fall of S-wave ve-

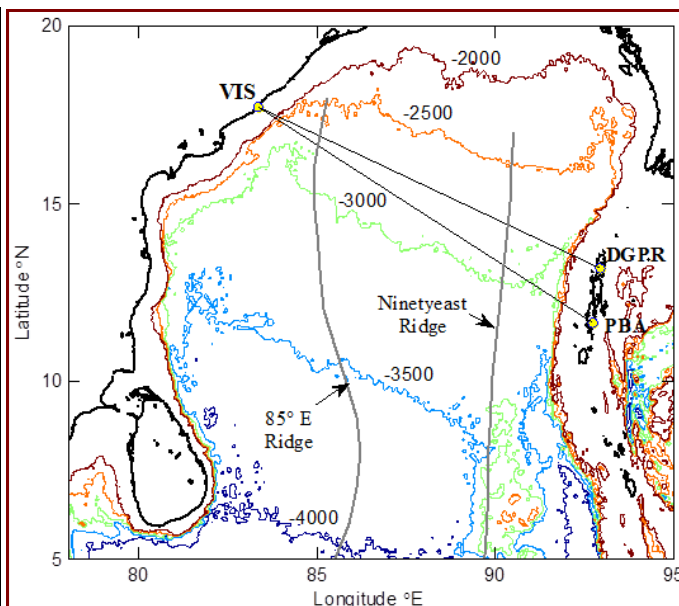


Figure 1. Locations of the observatories PBA, DGPR and VIS (triangles) and the interstation wavepaths used in this study. The contours over the Bay of Bengal show the ocean depths in meters.

loity below the mantle lid appears to indicate a partially molten thin layer (G - discontinuity) at this depth. **Continued in Page 4**

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ISES at a Glance

- ◆ ISES invites research articles for the first issue of open e-Journal, **Journal of Earthquake Science (JOES)** before 30th April, 2013.
- ◆ JOES will be freely available around the world and it is an open access online e-journal in the field of Geosciences/ Earthquakes.
- ◆ All the instructions related to manuscript submission are available at <http://www.joes.org.in> or alternatively contact us by e-mail at editor.joes.org.in@gmail.com.
- ◆ Researchers participated and presented their work in AES-2011 & AES-2013 are encouraged to submit their full paper.
- ◆ JOES will get ISSN soon and ISES will try to make it SCI journal as soon as possible.
- ◆ Bhoo-Kampan is now published with International Standard Serial Number, ISSN 2320-6217.

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Earthquake Science

Bhoo-Kampan

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Continued from Page 3 The thickness of the mantle lid is intermediate between oceanic and continental regions. The lid is also characterized by low radial anisotropy which decreases to near isotropy at the bottom of the lid. These two characteristics show a 'continental-like' mantle lid beneath the Bay. Rapid northward motion of the Indian plate before its collision with Eurasia might have caused the large radial anisotropy observed below the mantle lid.

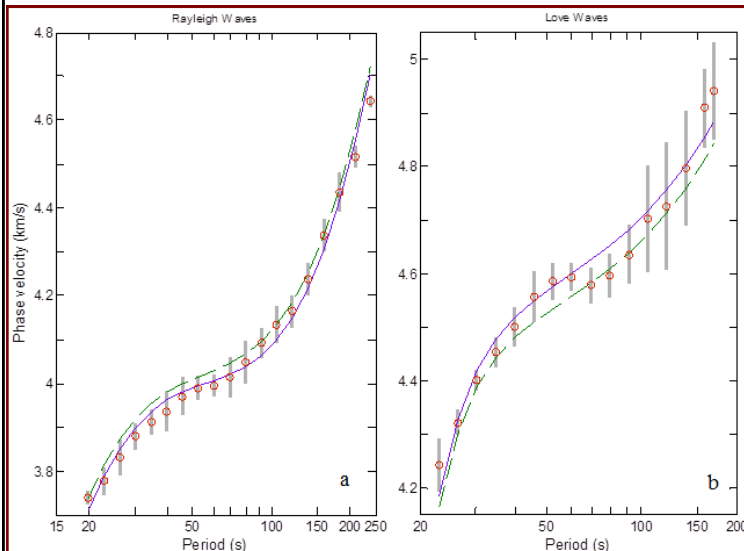


Figure 2. Observed mean phase velocities of (a) Rayleigh and (b) Love waves are shown by small red circles; vertical thick grey lines with these circles show ± 1 std. deviation. The theoretical curves for the accepted model are shown by continuous blue curve. The dashed green curve is the theoretical curve for isotropic model with P wave velocity mean velocity of PH and PV and with S wave velocity as mean of SH and SV for the accepted radially anisotropic model.

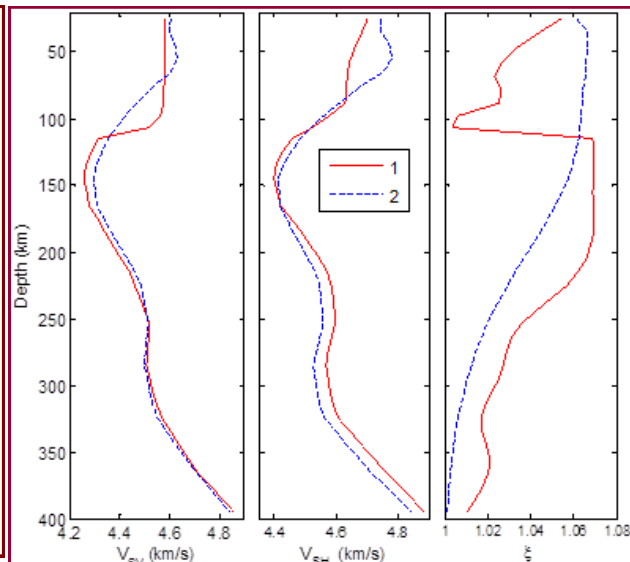


Figure 3. Shear wave velocities and radial anisotropy (ξ) in the upper mantle: **1.** Accepted model for the Bay of Bengal, **2.** Pacific model (110+ my).

Miscellaneous News

Scientific drilling through the Deccan Traps near Koyna has revealed a ~933 m – thick pile of basaltic flows, which is underlain by granitic basement rocks. The Koyna Bore Hole – 1 (KBH-1) located at Rasati, ~2.5 km SSW of Koyna Dam and in close proximity to the 1967 M 6.3 Koyna earthquake, reached a depth of 951 m on January 17, 2013 and further drilling is in progress. This is the deepest borehole so far in this part of the Western Ghats region, and the first one to penetrate the basaltic pile. The drilling is being carried out as part of a major scientific programme funded by the Ministry of Earth Sciences, Government of India to investigate seismicity in the Koyna-Warna region.

Absence of earthquakes in the top ~1 km in the area matches with the 1 km depth of Deccan Traps (Harsh Gupta, Shailesh Nayak and Koyna Workshop Committee, Scientific Drilling, 2011).

Previous estimates of the thickness of Deccan Traps in the region, from active seismic experiments carried out along Guhagar-Chorochi and Kelsi-Loni profiles during 1975-1978 as well as other geophysical studies range from less than 1 km to about 2 km (Kaila et al., Tectonophysics, v.73, pp. 365-384, 1981 and references therein).

Source: JOUR. GEOL. SOC. INDIA, VOL.81, FEB. 2013

A new study predicts that 3.5 million people will have died in catastrophic earthquakes between 2001 and 2100. Four catastrophic quakes (those that kill 50,000 or more people) have already hit since 2001. There was only one per century before 1900, and seven between 1900 and 2000. The total death toll from temblors so far this century is more than 700,000.

Tom Holzer and James Savage from USGS analyzed historic records of earthquake deaths dating back to A.D. 856, then compared those events to world population estimates. Depending on which death catalog they used, the expected number of fatalities from catastrophic earthquakes in this century will be 2.3 million to 5 million, the study found. The most reliable catalog gives an estimate of 3.5 million, from 21 catastrophic earthquakes.

Holzer cautions that the increase in killer quakes isn't from more frequent earthquakes, but from more people living in poorly constructed buildings in shake-prone regions. "There are places, like along the front of the Himalayas, that are just waiting for another disaster," he said. "China, the Middle East and many of the cities in these places just don't design to resist earthquakes. About 62 percent of the world's population lives in countries with a significant seismic hazard, or risk of earthquakes.

Source: Becky Oskin, OurAmazingPlanet | LiveScience, Feb 21, 2013