Registered with the Registrar of Newspapers of India : R.N. 70269/98

ISSN : 0972-169X
Postal Registration No. : DL-11360/2000

Monthly Newsletter of Vigyan Prasar

DREAM 2047

February 2001 Vol.3 No. 5

VP News

Inside

Vigyan Prasar - AIR Radio Serial: Prithivi Aru Antariksha

Radio as a means of science popularization has always played a vital role in India due to its all pervading reach and affordability of the masses. Vigyan Prasar (VP) has always been striving to utilize this medium in its efforts to take science to the people. As a result three very successful serials were jointly produced and broadcast since 1997; viz. "Paryavaran Calling" with AIR Bhopal, "Bipanna Basudha" with AIR Guwahati, and "Chhoo Mantar" with AIR Delhi. All India Radio, Dibrugarh (AIRD) took keen interest to collaborate with Vigyan Prasar and produce a 26-part science serial "Prithivi Aru Antariksha" (the Earth and the Space).

A workshop to plan for this serial and identify the topics, experts, and to finalize operational aspects, was organised by VP at Dibrugarh on 24-25 January 2001. About 30 experts from academic institutions, research laboratories and science popularizing agencies participated in this workshop jointly organised by AIRD and VP. Dr. Devdas Kakati, Vice-Chancellor of the University, inaugurated the workshop on 24 January 2001 in the presence of a host of eminent personalities of Assam. Dr. Kakati appealed to the scientific community to address to the needs of the society and interact more with the common man. The other speakers included Shri Munin Bhuyan, Station Director of AIRD, Shri A.K. Misra, Fellow, VP, and Shri N.C. Tumung, Asstt. Station Director of AIR, Dibrugarh.

A section of the participants in the workshop on "Prithivi Aru Antariksha" discussing various aspects of the project.

During the course of the workshop, 26 topics were identified. In order to cater to a wide target group, with special emphasis on students, it was decided to frame most of the episodes in a drama or feature mode. Every episode would contain a simple introduction to the topic and comments from some experts. Each episode would end with 5 quiz questions related to the particular topic. Provision for registered listeners and phone-in quiz would be incorporated. The broadcast would begin from 06 April with a curtain raiser episode to be followed by 26 independent episodes. There would also be a valedictory episode on 28 September 2001 to summarize the entire project. The broadcast time would be on Friday evenings at 8:00-8:30 pm. Dr. Paramananda Mahanta, Professor of Physics, Dibrugarh University was unanimously voted the Coordinator of the project to steer it through the 6 months.

• • •

... think scientifically, act scientifically ... think scientifically, act scientifically ... think scientifically, act...

Published and Printed by Dr. Subodh Mahanti on behalf of Vigyan Prasar, C-24, Qutab Institutional Area, New Delhi-16 & Printed at Shagun Offset, 132, Mohammadpur, Bhikaji Cama Place, New Delhi-110 066

Editor : Dr. V.B. Kamble

Rising From the Rubble

As the country was celebrating the 52nd Republic Day, the Earth shook violently in Gujarat sending tremors all over the country and all the way to Nepal and China. The cities and villages that stood testimony for centuries to the vicissitudes of history were reduced to a heap of rubble during those fateful two minutes. Even the cities far from the epicentre – Ahmedabad (300 kms) and Surat (400 kms) were not spared. Besides the thousands of human lives lost, the loss to livestock, property, houses and structures was enormous. Those who survived were not too fortunate either. Their world has completely changed.

The first phase of providing immediate relief in the form of shelter, food, medical treatment, clearing the debris, providing potable water, and fuel etc. would be completed in near future. Despite sympathies, and relief reaching them from all over the country and different parts of the world, it would be a long time, probably years before those affected could be successfully rehabilitated. The fear-psychosis and the trauma that have gripped the survivors, revival of their confidence in themselves, construction of earthquake-proof houses, continuing medical care of those left disabled, re-establishment of schools, offices and institutions, care of the orphaned children and their education, special attention to women who lost their families and their rehabilitation are but a few aspects Government and non-Government organisations will have to address their attention to.

Yet another aspect is that such calamities lead the affected people to reinforce their belief in fatalism and superstitions. It is both a duty and challenge to those engaged in the relief operations – and those engaged in science communication – to explain to them the difficulties involved in scientific predictions as a result of incomplete data or the incomplete understanding of the scientific phenomena. It is essential to establish once again their belief in science and scientific approach helping them resolve the conflict within – heart and head pulling in opposite directions.

It is unfortunate that the young science of seismology – dating back no more than a century – still cannot predict with certainty when and where the Earth will next shake and release its destructive energy from within. What science can now tell us is which areas on the Earth's surface are more prone to earthquakes. It is still more unfortunate that this knowledge was available but not used in Kutch. Nor has it been used in the North and the North-East, the regions more commonly associated with earthquake dangers in India. Although the location of future events of major seismic activity can be identified with some probability, the probability of success in locating their timing remains extremely low. The country cannot afford to go through the agonising trauma of another Gujarat. During floods and cyclones, at least we have some time to evacuate the people to safer places. Not so with earthquakes. This then is a sufficient reason why we need to launch vigorous programmes on "earthquake preparedness" in regions or zones identified as vulnerable to major earthquakes. There is not much time to lose.

Where do we begin? Here are a few suggestions: (1) Development, production and dissemination of educational packages, posters and publications giving scientific information on earthquake phenomena and on topics such as design of earthquake resistant houses, do's and don'ts to minimise the loss of human life and damage to property, and other relevant software; (2) Organise awareness campaigns/programmes giving scientific information and tips to minimise loss of life and property; (3) Development of core-groups especially in the earthquake prone regions and familiarising them with physical and emotional needs of the victims – educational, medical, housing and obtaining financial assistance to initiate a trade etc. and continuous rapport with scientific and Government/non-Government agencies for better co-ordination during relief operations and rehabilitation programmes; (4) Promotion of ham radio activity for establishment of emergency communication network. Incidentally, ham radio has proved its utility time and again during several natural calamities earlier and also during the present disaster. NCSTC/Vigyan Prasar ham radio station actively participated in establishing an emergency communication network with ham stations set up in the affected areas of Kutch and at other places; (5) Training of village persons in first-aid in collaboration with District and Village Panchayat authorities and Primary Health Centres and development of a medical kit for use during disasters; (6) Carrying out earthquake drills in schools and development of an earthquake survival kit; (7) Development of websites giving important and latest information on topics related to earthquake.

Meanwhile, Gujarat continues to feel tremors. Let us sympathise and empathise with the affected people, identify their problems and work for possible solutions, thereby helping them in the process of rehabilitation. Let us help Gujarat rise from the rubble as fast as possible. We cannot avoid disasters, but we can learn to manage them.

❑ **V.B. Kamble**

Editor	:	V.B. Kamble
The team	:	Vigyan Prasar Staff

Vigyan Prasar

Address for correspondence : *C-24, Qutab Institutional Area, New Delhi-110 016*
Tel. : 6967532; Fax : 6965986
e-mial : vigyan@hub.nic.in
website : http://www.vigyanprasar.com

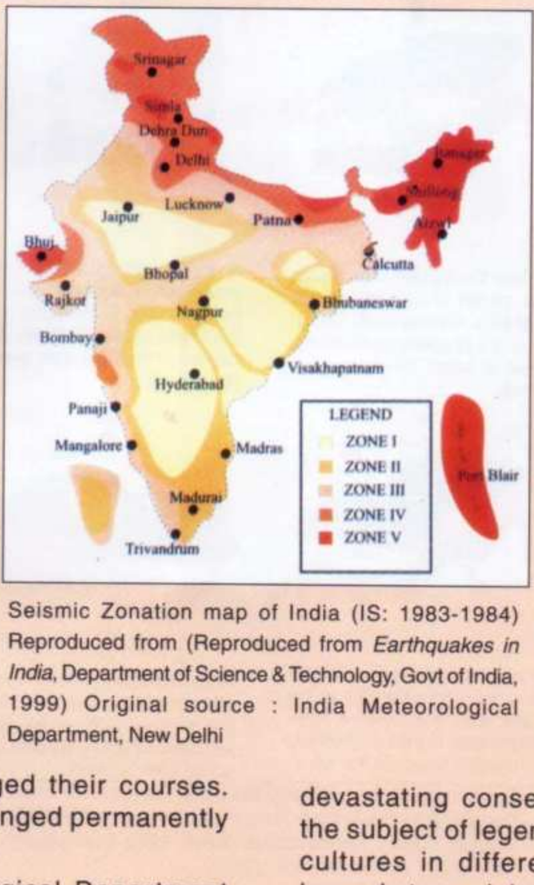
EARTHQUAKES

❑ *Subodh Mahanti*

> Scientists still do not appear to understand sufficiently that all earth sciences must contribute evidence towards unveiling the state of our planet in earlier times, and that the truth of the matter can only be reached by combing all this evidence...It is only by combing the information furnished by all the earth sciences that we can hope to determine 'truth' here , that is to say, to find the picture that sets out all the known facts in the best arrangement and that therefore has the highest degree of probability. Further we have to be prepared always for the possibility that each new discovery, no matter what science furnishes it, may modify the conclusions we draw.
>
> ***Alfred Lothar Wegener in the Origins of Continents and Oceans (1929)***
>
> "We cannot prevent earthquakes; however, we can significantly mitigate their effect by identifying hazards, building safer structures and providing education on earthquake safety"
>
> "Earthquakes are part of a global tectonic process that generally occurs well beyond the influence or control of humans".

Earthquakes are considered to be one of the worst natural hazards causing widespread disaster and loss of human lives. The impacts of earthquakes normally cover large areas causing deaths, injuries and destruction on a massive scale. Though they have high consequences, they have low probability. For this reason the post-disaster response takes place on adhoc basis without any prior preparedness. Destruction can be so swift and sudden that people have no time to escape. In the last two decades (1980-2000) 26 major earthquakes have occurred in different parts of the inhabited Earth which killed about 1,50,000 people.

On 26 January at 8:46:41 IST at a latitude of 23.40, longitude 70.32, Depth 23.6 km an earthquake suddenly struck in western Gujarat when the President of India was taking salute at the 52nd Republic Day. This changed the joyous mood of the nation into a national sorrow. The earthquake was the most powerful to strike India since August 15, 1950 when an 8.5 magnitude earthquake killed 11,538 people in northern part of Assam State. In 1897 the earthquake that occurred in the Shillong plateau had a magnitude of 8.7. These two earthquakes were so intense that rivers changed their courses. What is more, ground elevation changed permanently and stones were thrown upward.



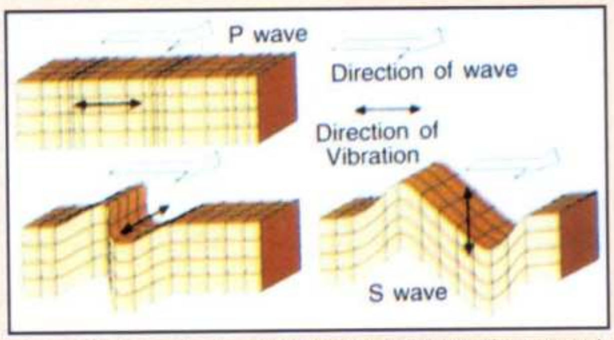
Seismic Zonation map of India (IS: 1983-1984) Reproduced from (Reproduced from *Earthquakes in India*, Department of Science & Technology, Govt of India, 1999) Original source : India Meteorological Department, New Delhi

According to India Meteorological Department the Earthquake of 26 January 2001 measured 6.9 on the Richter scale, but the US Geological Survey put its magnitude at 7.9. There were at least 83 aftershocks, several measuring upto 5-6 magnitude in the 10 hours after the earthquake. The earthquake, close to the border with Pakistan, caused high rise buildings to sway far away in the capital, New Delhi and was felt away in Nepal and in Bangladesh. The epicentre was near Bhuj, a desert town of 150,000 people in Gujarat. Some experts compared the magnitude of this earthquake to the detonation of a 60 megaton hydrogen bomb. It will take years to properly rehabilitate the affected ones.

Nobody can remain without being affected from such an earth-shaking disaster. Everytime we confront an earthquake it leaves a host of more or less similar questions in our minds. Why earthquakes occur? Can earthquakes be predicted? Why earthquakes are confined to certain regions of the Earth's surface? Why the magnitudes vary? Can the collapsing of the buildings be prevented? When was the last earthquake? When and where there will be a next earthquake? What do we mean by focus or an epicentre of an earthquake? How the damage can be minimised ?

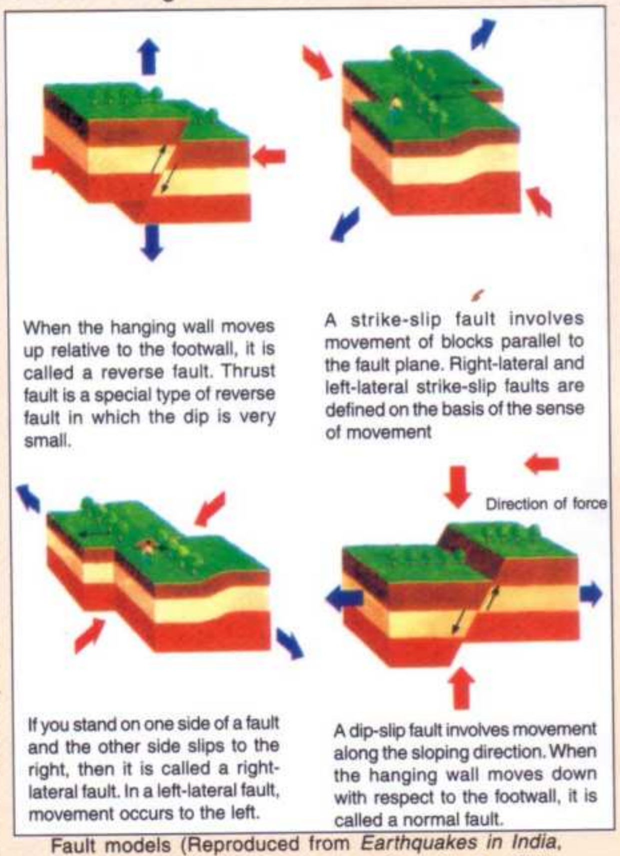
Because of their tremendous devastating consequences earthquakes have been the subject of legends and myths. In the past, different cultures in different times had taken recourse to legends to explain the mystery of the 'shaking earth'. Though scientists are yet to fully understand the earthquake processes,they have developed a framework which provide explanation for spatial and temporal recurrence patterns of global earthquakes.

An earthquake may be defined as the shaking of the Earth's surface as a result of the sudden release of the stresses built up in the Earth's crust (the solid, rocky outer portion of the Earth). This may range from mild tremor to a large-scale earth movement causing extensive damage over a wide area. The point at which the earthquake originates is known as the seismic focus and the point on the Earth's surface directly above this is the epicentre or hypocenter. The location of the epicentre is expressed by latitude and longitude.



Propagaiton of seismic waves through the Earth (Reproduced from *Earthquakes in India*, Department of Science & Technology, Govt of India, 1999); *original source* : Bolt, B.,(1993) *Earthquakes*, W.H. Freeman and Company, New York)

Most earthquakes occur along faults (fractures or breaks in the crust). A fault is a fracture or break in the Earth's crust along which movement occurs. If the movement has a major vertical component the fault is called a normal fault, where rocks on each side have moved apart or a reverse fault where one side has overridden the other. A low angle reverse fault is called a thrust. A lateral fault or tear fault occurs where the relative movement is sideways. Faults may range in length from a few millimetres to thousands of kilometers. Most faults produce repeated displacements over geologic time.

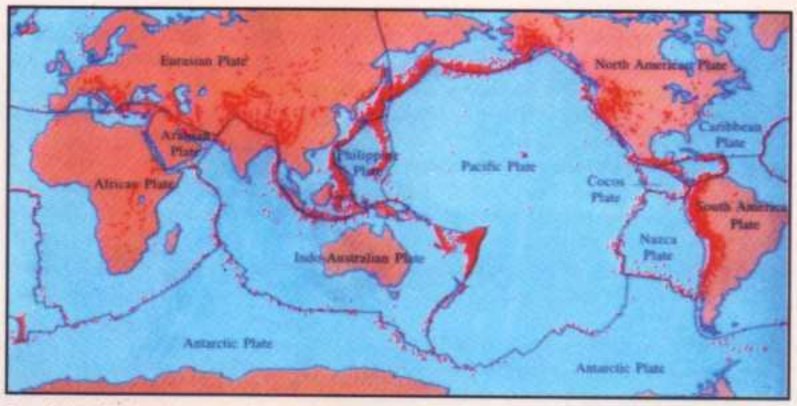


Fault models (Reproduced from *Earthquakes in India*, Department of Science & Technology, Govt of India, 1999). Original Source: Earthquake in Japan, 1996. Science and Technology agency of Japan, Tokyo.

An earthquake generates vibrations that propagate within the Earth or along its surface - two types of body waves that travel within the Earth and two types of surface waves. The physics of seismic waves is rather complex. The primary or longitudinal body waves or P-waves impart a back-and-forth motion to rock particles along their path. They travel at speeds between 6 km per second in the surface rock and 10.4 km per second near the Earth's core. Secondary or transverse body waves or S-waves cause rock particles to move back-and forth perpendicular to their direction of propagation. They travel at between 3.4 km per second in surface rock and 7.2 km per second near the core. The surface waves consist of Rayleigh waves and Love waves. Rayleigh waves, named after Lord Rayleigh (1842-1919) who predicted them, travel over the surface of an elastic solid giving an elliptical motion to rock particles and have the strongest effect on distant seismograph. The Love wave, named after Augustus Edward Hough Love (1863-1940) displace particles perpendicularly to the direction of propagation and have no longitudinal or vertical component.

P-waves are the first to cause vibration of a building. After P-waves comes the S-waves, which cause structure to vibrate from side to side. As buildings are more easily damaged from horizontal motion than from vertical motion, P-waves are the most damaging. Rayleigh and Love waves arrive last. While P- and S-waves mainly cause high frequency vibrations but Rayleigh and Love waves cause low frequency vibrations. The resulting vibration of the ground and building caused by body and surface waves is rather complex–hard, gentle, long, short, or rolling. Seismic waves travel at different speeds in different types of rocks.

According to plate tectonics theory the Earth's outermost layer or the crust is regarded as a jigsaw of rigid major and minor plates up to hundreds of kilometers thick, which move relative to each other, probably under the influence of convection currents in the mantle below. The whole globe is divided into a number of seismic plates. The major plates are : Antarctic Plate, Eurasian Plate, Australian Plate, Philippine Plate, Juan De Fuca Plate, North American Plate, Cocos Plate, Pacific Plate, Caribbean Plate, Nazca Plate, South American Plate, Scotia Plate, Arabian Plate, African Plate, Indian Plate. The Indian and Australian plates together are called Indo-Australian Plate. Major landforms occur at margins of the plates where the plates are colliding or moving apart. The plates move very slowly and sometimes slide past each other. Most severe earthquakes occur when the plates meet. Sometimes the edges of the plates grip each other and cannot move, so pressure builds up. Suddenly the plates slip and lurch past each other making land shake violently. In the process the Earth's crust gets ruptured causing huge faults. Once faults are formed they become areas of weakness and earthquakes which are means of releasing energy to remove accumulated strain are mostly confined to the existing faults. New faults are caused when the strain is released at places away from the existing ones.



Boundaries of major tectonic plates and distribution of earthquakes (Reproduced from *Earthquakes in India*, Department of Science & Technology, Govt. of India. 1999) original source : Judson, S.and Richardson, S.M. (1995), *Earth : An Introduction to Geologic Change* Prentice Hall, Engeswood, New Jersey

The concept of the continental drift was first put forward in 1915 by the German geophysicist Alfred Lothar Wegener (1880-1930) and the theory of plate tectonics was formulated by the Canadian geophysicist John Tuzo Wilson (1908-93) in 1965 and has gained widespread acceptance among earth scientists.

Alfred Lothar Wegener

Today we see that the continents are separated by oceans. But there was a time (say some 225 million years ago) when there was only one single continent called Panagea. The rest of the Earth's surface was occupied by the ocean. Then some 200 million years ago Panagea split into two major continents called the Laurasia (which included what are now North America and Eurasia) and Gondwanaland (which included what are now India, Australia, Africa, South America and Antarctica). Once separated these two major continents started drifting in different directions over the surface of the Earth. These two continents further split into a number of smaller land masses and continued to move in different directions. The Indian Plate or the India landmass travelled at a speed say, 9 meters per century for millions of years before it collided with Asia or the Eurasian plate about 40-50 million years ago. The collision was marked by the formation of the Himalayas.

While earthquake can strike any location at any time but the history of earthquake shows that there are three large zones of the Earth where the occurrence of earthquakes is more frequent than in other places. The first zone is the Circum-Pacific Seismic belt, the world's, greatest earthquake belt where about 81 percent of the world's largest earthquakes occur. The belt which is found along the rim of the Pacific Ocean, extends from Chile, northward along the South American coast through Central America, Mexico, the West Coast of the USA and the southern part of Alaska, through the Aleutian islands to Japan, the Philippine Islands, New Guinea, the Island group of the southwest Pacific, and to New Zealand. The second important belt, the Alpide, accounts for about 17 percent of the world's largest earthquakes. It extends from Java to Sumatra, through the Himalayas, the Mediterranean and out into the Atlantic. The third important belt follows the submerged mid-Atlantic Ridge.

John Tuzo Wilson

Earthquake exclusive on Vigyan Prasar Web Site

Realising the need to provide correct and fast information related to the earthquake to the public, Vigyan Prasar got the same on its website www.vigyanprasar.org and www.vigyanprasar. com within a day of the quake. This was the right medium as many from the Indian diaspora had Internet as the only medium.

Keeping in view the necessity of the hour, the VP homepage was updated immediately. As a matter of fact, Vigyan Prasar web site now has everything-from the hows and whys of earthquake to the history of earthquake, a continuous news ticker carrying updates on the quake information with links to national and international media reportage besides providing a whole lot of general earthquake related information. It is a one stop site for those who are searching for paths to the most recently developed Gujarat earthquake information sites.

The contents are categorized under the headings -The Catastrophe, Support, News, Facts, Technical Data, Articles and Web Surf. If you want to know about the affected areas, interested in an epicenter map, require taluk-wise details, village reports, list of patients in various hospitals, then this site is ready with all the information for you. You can have ready access to the help-line telephone numbers, ham radio help-line, other governmental information as well as 'place specific' links for places like Bhuj, Kutch, PanjoKutch and Ahmedabad in the 'Support' section. The 'News' section comes bundled with continuously updated news tickers with headlines and links to the national and international news reportage sites, pictures, earthquake bulletin etc..

The site also offers general information like-major quakes, history of earthquake, earthquake fact sheet and global earthquake map. The site tells about how to face a disaster, learning lessons and helps generating awareness in disaster preparedness as well. There are also 'tips' to face a disaster. For the more technical minded people, it provides many 'technical data' related to earthquake with a live web camera for seismic watch, information about current seismicity, historical seismicity, special event page, P-wave travel etc.. Articles like 'Palaeoseismology', 8000 years history, past 200 years etc. enhances the content while the 'Web Surf' section helps the earthquake enthusiasts in going to the right web site. There are also links to web sites giving details about the relief operations and raising funds for the victims. There are dozens of links to important web sites offering the facility of a "virtual" earthquake, about building a seismograph, information on the latest quakes, predictions, seismo surf, earthquake engineering, simple earthquake glossary, technical earthquake glossary, techniques of measuring quakes and so on. There is also a special section on 'Earthquake for the kids'.

Sandeep Baruah

In the Indian plate, faults are created when this rubs against the Eurasian plate. The Allabund fault, on which the epicentre of the earthquake of 26 January fell, has witnessed major earthquakes in the past. The earthquake of 1819 had a magnitude of 8.0 on the Richter scale and was located 20 km north of Bhuj. The Allabund fault, which is a minor fault has history of earthquakes. Since 1956 eighty-five earthquakes of varying intensities have been recorded from the same area.

A large part of India is liable to a wide range of probable maximum seismic intensities. Earthquakes in India are caused by the release of elastic strain energy created and replenished by the stresses from the collision between the Indian plate and the Eurasian plate. The most intense earthquakes occur on the boundaries of the Indian plate to the east, north and west. Two premier government organisations viz., India Meteorological Department (IMD) and Geological Survey of India (GSI) are primarily responsible for monitoring the earthquake hazard in the country. The IMD is the national agency for detection and locating earthquake and for the evaluation of seismicity in different parts of the country. The first seismological observatory was established by IMD in 1898 in Kolkata (then Calcutta). Today it has observatories round the country. The country has been divided into five different seismic zones, V to I with respect to the severity of the earthquake on a decreasing scale—Zone I (no risk); Zone II (low risk); Zone III (moderate risk); Zone IV (high risk) and Zone V (very high risk). A catalogue prepared by the India Meteorological Department has listed about 1200 earthquakes known to occur in India.

The major earthquakes (magnitudes are given in brackets) that hit India in the 20th century are given below :

April 4, 1905	In Kangra (8.0) in Himachal Pradesh. It killed thousands.
January 15, 1934	Near Bihar-Nepal border (8.3). It caused extensive damage in Kathmandu, Patna and Darbhanga.
June 26, 1941	Andaman Islands (8.1)
August 15, 1950	Assam (8.5)
January 19, 1975	Kinnaur and Lahaul Spiti in the Himalayas (6.2)
August 21, 1988	Near Bihar-Nepal Border (6.5). It killed 900 people.
October 20, 1991	Uttarkashi (6.6). It killed over 1600 people.
September 30,1999	Latur, in Maharashtra, (6.3). It killed more than 10,000 people.
May 22, 1997	Jabalpur region, Madhya Pradesh (6.0). About 40 people were killed.
May 29, 1999	Chamoli Area in Uttaranchal (then Uttar Pradesh) (6.8). Caused extensive damage.

A large earthquake is often followed and preceded by tremors of different intensities. To describe this phenomenon seismologists have coined three terms— foreshock, mainshock and aftershock. In any cluster of earthquakes, the one with the largest magnitude is called the mainshock, anything before it is called foreshock and anything after it is called an aftershock.

A list of some of the significant earthquakes in India and their location

Date	Epicentre	Magnitude
1819 June 16	Kutch, Gujarat	8.0
1869 Jan 10	Near Cachar, Assam	7.5
1885 May 30	Sopore, J&K	7.0
1897 June 12	Shillong plateau	8.7
1905 April 4	Kangra, Himachal Pradesh	8.0
1918 July 8	Assam	7.6
1930 July 2	Dhubri, Assam	7.1
1934 Jan 15	Bihar Nepal Border	8.3
1941 June 26	Andaman Islands	8.1
1943 Oct 23	Assam	7.2
1950 Aug 15	AP-China Border	8.5
1958 July 21	Anjar, Gujarat	7.0
1957 Dec 10	Koyna, Maharashtra	6.5
1975 Jan 19	Kinnaur, Himachal Pradesh	6.2
1988 Aug 6	Manipur- Myanmar Border	6.6
1988 Aug 21	Bihar-Nepal Border	6.4
1991 Oct 20	Uttarkashi	6.6
1993 Sept 30	Latur-Osmanabad, Maharashtra	6.3
1997 May 22	Jabalpur, MP	6.0
1999 March 29	Chamoli, Uttar Pradesh	6.8
2001 Jan 26	Bhuj, Gujarat	7.9

Earthquakes induced by human activities like injection of fluids into deep wells for waste disposal and secondary recovery of oil and the use of reservoirs for water supplies have been documented in a few places in the USA, Japan and Canada. The most well-known human activity induced earthquake resulted from fluid injection at the Rocky Mountain Arsenal near Denver, Colorado. This happened in 1967. Its magnitude was 5.5 and was followed by smaller earthquakes.

The earthquakes having the same magnitude on the Richter scale may vary in damage from place to place. The extent of damage that an earthquake can cause may depend on more than one factor. The depth of the focus may be one factor. Earthquakes can be very deep and in such case surface damage may be less. The earthquake of 26 January 2001 was relatively shallow; less than 25 Km deep. The earthquake in Garhwal in March 1999 was also shallow. Earthquakes occur in the crust or upper mantle, which ranges from the Earth's surface to about 800 km. Surface rupture occurs when movement on a fault deep within the Earth breaks through the surface.

World wide earthquake frequency

Descriptor	Magnitude	Average annually
Great	8 and higher	1
Major	7-7.9	18
Strong	6-6.9	120
Moderate	`5-5.9	800
Light	4-4.9	6,200 (estimated)
Minor	3-3.9	49,000(estimated)
Very Minor	<3.0	

Magnitude 2-3 about 1,000 per day
Magnitude 1-2 about 8,000 per day

During an earthquake one feels a swaying or small jerking followed by a small pause, and then a more vigorous rolling or jerking motion. For small earthquakes the ground shaking usually lasts only a few seconds but the ground may continue to shake for more than a minute in a major earthquake. The ground continued to shake for about three minutes on the occasion of the 1964 Alaska earthquake whose magnitude was 9.2. The duration of ground shaking resulting from earthquake depends on various factors like distance from the epicentre, the condition of the soil and, if one stands on a building, then the height of the building and the type of material it is constructed of.

Damages by earthquake primarily occur due to collapse of structures or buildings. The damage can be substantially minimised by incorporating proper safety measures. Everytime an earthquake strikes, the need to enact proper laws to make earthquake safety norms binding on buildings is highlighted. Codes and guidelines for earthquake resistant building have been developed by the Bureau of Indian Standard's code of practice. They were first developed in 1962 and 1967. Subsequently they were revised, updated and expanded every few years until 1993. But the code is only recommendatory in nature. So their implementation has not been satisfactory perhaps with exception of some government organisations. Such legislations should include amendment to the Town and Country Planning Act, Master Plan Development Rules, empowering development authority to exercise necessary control and incorporation of safety requirements in building bylaws of local bodies.

Fatalities can be reduced if the aftermath relief work can be organised timely and efficiently. This requires cranes, blow-torches, sniffer dogs and acoustic devices, doctors, particularly orthopaedic surgeons, and blood supplies. Then we need to organise temporary shelter, blankets and food. For managing the post-disaster scenario most effectively we require to place more emphasis on the following:

- extensive public awareness campaigns especially in rural areas

- greater involvement of NGOs and private sectors
- effective communication system

Recent experiences have demonstrated the utility of Ham Radio in establishing contacts with the affected area where normal communication network breaks down. Efforts are to be made to popularise Ham Radio. Internet can help us in making all kinds of relevant information available from different parts of the globe without any time lag.

Large earthquakes cause violent motions of the Earth's surface. Sometimes they cause huge sea waves that sweep up on land and add to the general destruction, such waves often occur in the Pacific ocean because of many earthquakes there for which

Gujarat Earthquake : How Ham Radio Played its Role

The Indian radio amateurs (ham radio operators) once again rose to the occasion and proved their mettle when they rushed to the earthquake devastated areas of Kutch in Gujarat and quickly established wireless communication links to all the parts of the country. Nearly 50 amateur radio stations became operational in Gujarat to handle emergency communication related to relief operations and enquiries from the anxious families in the rest of the country about the well-being of their near and dear ones in the affected areas. Ham radio operators from different parts of the country volunteered their service to the government agencies, NGOs, individuals and other volunteers engaged in relief operations.

Base stations were established in all the worst affected areas, viz. Bhuj, Anjar, Gandhidham and Bhachau, the control room being at Gandhinagar, along with a number of mobile stations. To co-ordinate the relief operations, a ham radio station was functioning even from the residence of the Chief Minister, Gujarat. In Delhi, ham radio stations were set up at the office of the Resident Commissioner Gujarat and the Ministry of Agriculture. The National Council for Science & Technology Communication & Vigyan Prasar amateur radio station VU2NCT started its operation on 29th January, 2001 as a disaster communication station to handle the messages from those making inquiries about the welfare of their relatives in the quake affected areas besides handling the traffic related to relief operations. During its 10 days of operation, approximately one hundred messages were handled by VU2NCT. Collecting information about the well-being of the persons in the devastated area was obviously not quite an easy job as most of the ham radio operators were from outside states with limited resources and manpower. They were operating from make-shift camps facing problem of power supplies and had to even run their wireless sets from car or jeep batteries. Considering the difficulty, we had to remain content getting feedback on a mere 20 of the total queries transmitted to the ham radio stations operating from the disaster affected areas.

"....Victor Uniform two United Tango Mike, this is Victor Uniform two November Charlee Tango operated by two Mike United Echo. I have one QSP for you: Prema Gopalan is reaching Bhuj with a truck of essential supplies. Convey this message to Sushma Iyengar in Bhuj Collector's office with instruction that she passes this message to "Navanirman Abinayan Samiti" (an NGO)". Within minutes, the ham radio operator Purusottam, VU2UTM, at the other end located at Bhuj Collector's office returned a prompt reply from his station that the message was conveyed to the NGO. We were constantly in touch with the ham radio stations operating from the camps and passing on messages through our HF radio.

For systematic flow of messages from point of origin to point of delivery in the shortest possible time, ham radio operators use High Frequency (HF) long distance radio sets as well as short range Very High Frequency (VHF) radio sets. Short range VHF sets found their utility in coordinating relief efforts of the local administration. While the radio wave propagation condition was suitable in the 40m ham band for communication within Gujarat, 20 meter was suitable for communication to the other parts of the country. When messages could not be passed directly to a particular ham radio station, it was re-routed through ham radio stations in Mumbai, Hyderabad or stations located elsewhere in the country. Some stations like VU2AF, Adolf (Mumbai), VU2SL, Dalvir (Valsad, Gujarat) were operating round the clock for any emergency relay assistance.

"VU2NCT this is VU2PHR, Pawan, from Samakhiali relief camp. Please ring up Delhi land line number 5469517, Ranjit Kaur, and inform that relief volunteer Amrutpal Singh is fine at Samakhiali relief camp. He is now leaving for Duda, some 14 kms away from this place. Also please ring up land line number 5138205, Sunder Singh, and inform that relief volunteer Paramjeet Singh will be at Samakhiali relief camp for the next couple of days."

"VU2NCT this is VU2RIO, Pankaj from Anjar... Please ring up 2289731, Dr. Sujata and tell her that Dr. Sunil is OK at Anjar." That was from Dr. Sunil who had rushed to Kutch as a member of a medical team from New Delhi. These are just a few examples of messages out of the hundreds of messages we had handled at VU2NCT.

One of the prominent ham like Shri Sahruddin, VU2SDN (President, Amateur Radio Society of India) spent hours at VU2NCT. Noel, VU2BRB and Gaurav, VU2GTI were two other local hams assisting VU2NCT during its operation, which was manned by Shri Sandeep Baruah VU2MVE and Dr. Vinay B. Kamble, VU2VBK.

Having read about the role played by the NCSTC-VP ham radio station, 20 school children from Dayanand Anglo Vedic Public School, Mukherjee Nagar, Delhi visited the VU2NCT Amateur Radio Station on 7th February, 2001 for a demonstration and exchanged pleasantries with hams in different parts of the country. The children were so keen on talking to a ham from the disaster affected area that when they did find one, they talked to him at length and enquiring about various aspects of the earthquake and relief operations. The children were very much impressed by on-the-air lecture delivered by Shri Dalvir, VU2SL from Valsad, Gujarat . He thanked all the children for the concern they had shown towards the affected people of Gujarat. Probably, again, it was once-in-a-life-time opportunity for these children when they could directly talk to another ham radio station (VU2RCR) located in Bhuj. Mr Ramchandran, VU2RCR is a 72 years old ham from Bangalore, who drove all the way from Bangalore to Bhuj leading a team of ham radio volunteers along with VU2SBJ, Srikanth. Ramchandran, VU2RCR described the importance of amateur radio during a disaster and explained to the children why he was there in Bhuj. VHF mobile ham radio operation was also demonstrated to the children by contacting Karan, VU3GTF, a young and very active HF as well as mobile VHF operator in Delhi.

Sandeep Baruah, VU2MUE

geologists use a Japanese term 'tsunami' for the destructive waves. Tsunamis are often mistaken for tidal waves. Tsunamis are not caused by the tidal action of the Moon and Sun. The wave is not very high in mid-ocean but the distance between wave crests can be very long, more than 60 miles. It begins to rise as it nears the coast, sometimes growing to about 76m. The tsunami smashes onto the shore destroying buildings and carrying boats and ships far inland. Tsunamis are also caused by volcanic eruptions. The speed at which the tsunami travels decreases as water depth decreases. In the mid-Pacific where the water depths reach 3miles, tsunmai can travel at the speed more than 430 miles per hour. While the destruction caused by the ground shaking is confined to the vicinity of the epicentre, but tsunamis cause destruction both locally and at very distant location from the area of tsunami generation.

The recurrence of earthquakes is not very unusual. Approximately once in every 87 seconds somewhere in the world, the Earth shakes slightly. These tremors are strong enough to be felt, but cause no damage. On an average every year the Earth witnesses 800 earthquakes with a magnitude of 5.0-5.9 on the Richter Scale but without causing any damage. In addition to these, every year there are 18 major earthquakes measuring 7.0 to 7.9 on the Richter scale and one great earthquake measuring 8.0 and above. Fortunately, as scientists claim, most of these occur in uninhabited or virtually uninhabited areas.

Modified Mercalli Intensity Scale :

Grade of Indensity	Effects
I)	Not felt except by a very few under especially favorable circumstances.
II)	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III)	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration similar to the passing of truck. Duration estimated.
IV)	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably.
V)	Felt by nearly everyone; many awakened. Some dishes, windows broken. unstable objects overturned. Pendulum clocks may stop.
VI)	Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII)	Damage negligible in building of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motor cars.
VIII)	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX)	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X)	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
XI)	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
XII)	Damage total. Lines of sight and level distorted. Objects thrown into the air.

Source : USGS National Earthquake Information Centre

But then there are earthquakes which appear to be unusual to scientists. For example, three earthquakes exceeding a magnitude of 8 occurred in New Madrid (near Missouri in the US) within a span of about 7 weeks (December 16, 1811, Feb. 7 and 23, 1812). On January 22, 1988 three quakes of magnitude of more than 6 occurred in a span of 12 hours in Tennant Creek, Australia.

The magnitude of an earthquake is measured on the basis of the ground wave recorded by seismograph. Seismograph is an instrument that records ground oscillation. Most modern seismographs are based on the inertia of delicately suspended mass and depend on the measurement of the displacement between the mass and a point fixed to the earth. Others measure the relative displacement between two points on earth. Necessary correction for the epicentral distance from the recording station needs to be applied. The strength of an earthquake is measured on the basis of the maximum amplitude of the signal recorded by a seismograph and how far the instrument is stationed from the earthquake.

A seismometer may be a pendulum or mass mounted on a spring. A seismogram is the record produced by seismographs used to calculate the location and magnitude of an earthquake. On a seismogram, the horizontals axis represents time measured in seconds and the vertical axis represents the ground displacement usually measured in millimeters. The movement of a seismometer can be converted into a seismogram in several ways viz., a pen drawing on

The earliest seismoscope invented by Chinese philosopher Chang Heng in A.D. 132

ink line on paper revolving on a drum; a light beam making a trace on a moving photographic film and electromagnetic system generating a current that is electronically recorded on tape. In the absence of an earthquake the seismogram is just a straight line except for small wriggles caused by local disturbance or noise and the time marker. The earliest seismoscope was invented by the Chinese philosopher Chang Heng in AD132. The device was, a large urn with eight dragonheads on its outside facing the eight principal directions of the compass. The urn was attached to a base. Below each dragon head was a toad with its mouth opened towards the dragon. In the event of an earthquake one or more of the eight dragon-mouths would release a ball into the open mouth of the toad sitting below. The direction of the shaking determined which of the dragon released its ball. What was inside the urn is not known.

The Richter scale, named after the US physicist Charles F. Richter of the California Institute of Technology was first introduced in 1935. Richter evolved the scale from patterns he discovered by studying hundreds of earthquakes. The scale starts at one and has no upper limit. However, the largest known shocks have had magnitudes in the 8.8 to 8.9 range. As the Richter scale has a logarithmic basis each unit is 10 times greater than the one before. The Richter scale does not measure an earthquake's effects. It gives the measure of its strength in terms of the energy released as measured by seismograph. The earthquake of highest magnitude till date in the country is of 8.7 on the Richter scale which was recorded in the Shillong Plateau on June 12, 1897. Richter magnitude effects are confined to the vicinity of the epicentre.

The classification of earthquakes based on the magnitude on the Richter Scale.

Less than 2.0	Generally not felt, but recorded
2.0 - 2.9	Potentially perceptible
3.0 - 3.9	Felt by some
4.0 - 4.9	Felt by most
5.0 - 5.9	Damaging shocks
6.0 - 6.9	Destructive in populated regions
7.0 - 7.9	Major earthquakes; inflict serious damages
Greater than 8.0	Great earthquakes; causes extensive destruction near epicentre

It was found that the method developed by Richter for measuring the magnitude was strictly valid only for certain frequency and distance ranges. So to take advantage of the growing number of globally distributed seismograph stations new magnitude scales like body-wave magnitude (Mb), surface wave magni-tude (Ms) and moment magnitude (Mw) were developed. These scales were basically extension of the original idea developed by Richter. The moment magnitude gives most reliable estimate of earthquake size. Moment is a physical quantity proportional to the slip on the fault times the area of the fault surface that slips. The moment which can be measured from seismograms and also from geodetic measurements is related to the total energy released in the earthquake. Unlike other magnitude scale the moment magnitude gives an estimate of the size of the earthquake that is valid over the complete range of magnitudes.

How seismologists give a Richter magnitude to earthquakes that occurred prior to about 1880s (i.e. before modern seismographs came into use) ? To do this seismologists looked at the physical effects like faulting, landslides, sandblows or river channel change and also human effects (where records are available) like the area of damage or how strongly a quake was felt and compare them to modern earthquakes. As many assumptions need to be made for comparison, different seismologists got widely varying magnitudes by using different assumptions. So there is no wonder that many of the old earthquakes have big difference in the magnitudes assigned to them.

'Magnitude' and 'Intensity' are two ways of expressing the strength of an earthquake. The magnitude on the Richter scale is a measure of the seismic energy radiated by an earthquake. The intensity is a measure of the damage caused by the earthquake. The intensity measurement is based on observed effect. For intensity measurement the 12-point graded Modified Mercalli Intensity scale is widely used. A Grade-I earthquake is not felt except by a very few people under specially favorable conditions. An earthquake registering five on the Mercalli scale is defined as having had furniture to shake, many may wake up, wall plaster cracks, dishes and windows break, light objects overturn and pendulum clock can stop but causing little or no damage. But an earthquake measuring 12 on the Mercalli scale would destroy all man-used objects and create new topography by forming new lakes, huge falls of rocks and major earthquakes. The most devastating earthquake in recorded history was in China's Shaanxi province in 1556. It possibly measured nine on the scale and it killed 830,000 people.

In the late 1880s, John Milne, James Ewing and Thomas Gray developed a compact seismometer that could be installed in various locations around the globe. These instruments helped to gather the earliest data on geographic distribution of earthquakes and this in turn led to recognition of plate boundaries.

The following three developments in the second half of the 20th century helped major advances in seismology :

- The establishment of a network of 120 seismic stations by the US Govt. in the 1960s. The network was primarily established to detect underground nuclear test.
- The development of the theory of plate tectonics which helped to develop a framework for the basic dynamics of earthquakes.
- The development of computer technology that made possible to analyse large amount of data.

Despite these significant developments many gaps exist in our understanding of earthquake processes even in those locations where extensive data is available. Scientists are constantly revising their concepts. There have been two cases of accurate prediction of major earthquakes. The first one was the 1971 Blue Mountain Lake earthquake in New York. This was predicted by an Indian seismologist. The second accurate prediction was the case of the Heicheng earthquake in 1975 by a Chinese seismologist. Then the prediction for the Parkfield earthquake proved to be wrong. There is no scientifically established procedure for accurate prediction of earthquakes. Some experts tend to believe that precise earthquake predictions within narrow limits of time, location and magnitude may not be ever possible because of the complex and unreliable factors involved. This is inspite of the fact that earthquakes show a marked spatial distribution — the vast majority are located within narrow zones which correspond to the boundaries of the crustal plates. There are statistical techniques that can be used if all the necessary data are available to approximately predict when and where an earthquake will take place. But then prediction based on such methods are vague–the location can be anywhere within 200 km of a point and the time limit is 10 years. So such predictions, even if proved to be right, are useless for disaster preparedness.

While earthquakes cannot be stopped or accurately predicted but structures can be designed which can safely resist and negotiate the actions of earthquake ground motion. Earthquake resistant design of structures has grown into a true multi disciplinary field of engineering. Creating public awareness about all aspects of earthquake and post-earthquake scenario is essential.

Some Common terms that one may encounter While studying about earthquakes.

Active fault : A fault that is likely to have another earthquake some time in future.

Aseismic : The term refers to a fault on which no earthquake has been observed.

Benioff zone : A zone of earthquake epicentres distributed on well-defined planes that dips from shallow depths to as great as 700 kilometers.

Body wave : Seismic waves that travel either along or near the Earth's surface.

Crust : It is the uppermost part of the Earth. It consists of two distinct parts, the oceanic crust and the continental crust.

Core : The innermost part of the Earth, which is divided into an inner core, the upper boundary of which is 1,700 km from the centre and an outer core, 1820 km thick. Both parts are thought to consist of iron-nickel alloy. The temperature may be 3000^0C.

Dip : The angle that a stratum or fault plane makes with the horizontal.

Earthquake : A shaking or trembling of the crust of the Earth caused by breaking and shifting of rock beneath the surface or by underground volcanic process.

Epicentre : The point on the surface of the Earth directly above the focus of an earthquake.

Fault : A fracture in the Earth's crust along which there has been displacement of rock on one side relative to the other. The displacement ranges from a few centimetres to a few kilometres and may occur in horizontal, oblique or vertical direction.

Fault system : Two or more fault sets which interconnect.

Fault scarp : A steep cliff formed by movement along one side of a fault.

Fault trace or fault line: intersection of the fault surface with the surface of the Earth or any other horizontal surface of reference.

Fault throw : The amount of vertical displacement of rocks due to faulting.

Fault Zone : A fault expressed as an area of numerous fractures.

First motion : On a seismogram, the direction of ground motion as the P-waves arrives at the seismometer.

Forsehocks: A tremor which precedes a larger earthquake or mainshock

Fault terrace : A step on slope, produced by displacement of two parallel faults.

Geodesy : The branch of science concerned with surveying and mapping the Earth's surface.

Geology : The branch of science concerned with the origin, structure and composition of the Earth.

Geophysics : The branch of science in which the principles of mathematics and physics are applied to the study of the Earth's crust and interior.

Ground failure : A general reference to land slides, liquefaction, lateral spreads which any other consequence of ground shaking.

Ground motion : The movement of the Earth's surface caused by seismic waves which travel through the Earth and along its surface.

Interplate coupling : It means a fault between two plates is locked and capable of accumulating stress.

Isoseismal : A contour or line on a map, bounding points of equal intensity for a particular earthquake.

Lithosphere : The topmost layer of the Earth's structure forming the of plates that take part in the movement of plate tectonics.

Locked fault : A fault that is not slipping because of frictional resistance on the fault is greater than the shear stress across the fault. A locked fault is expected to store strain for extended periods. The frictional resistance is eventually overcome in an earthquake.

Love wave : A type of seismic surface wave having a horizontal motion that is transverse or perpendicular to the direction of the propagation of the wave.

Mainshock : The largest earthquake in a cluster of earthquakes. The mainshock is sometimes preceded by one or more foreshocks but almost always followed by many aftershocks.

Mantle : The immediate zone of the Earth between the crust and the core, accounting for 82 percent of the Earth's volume. The mantle is separated from the crust by the Mohorovicic discontinuity and from the core by the Gutenberg discontinuity. It is thought to consist of silicate Minerals Such as Olivine.

P-wave : The primary or the fastest seismic waves travelling away from an earthquake, consisting of a series of compressions and dilatations parallel to the direction of travel of the wave.

Paleoseismic : The history of seismic events which is determined by examining the layers of rock beneath the surface and how they have been displaced by earthquake in the past.

Plate tectonics : The theory that the Earth's surface consists of a number of plates or large crustal slabs whose slow but constant motion explain continental drift, mountain formation, etc.

Rayleigh wave : A surface seismic wave with retrogade, elliptical motion at the free surface. It is also know as R-wave.

Strike-slip fault : A fault on which the two blocks of rocks slide past one another.

Rupture front : The instantaneous boundary between the slipping and locked parts of fault during an earthquake.

Rupture velocity : The speed at which a rupture fault moves across the surface of the fault during an earthquake.

S-wave : A seismic body wave that shakes the ground back and forth perpendicular to the direction of propagation of the wave. It is also called shear wave.

Seismicity : The degree to which a region of the Earth is subject to earthquake.

Seismic movement : A measure of the size of an earthquake derived from the area of fault rupture, the average amount of slip and the force required to overcome the stress generated by the faulting.

Seismic wave : Generated by an earthquake, seismic waves are elastic waves and they travel either along or near the Earth's surface (surface seismic waves) or through the Earth's interior (body seismic waves)

Seismic zone : An area of seismicity probably sharing a common cause.

Seismogenic : Capable of generating earthquake.

Seismogram : The chart of an earthquake as recorded by a seismograph

Seismology : The branch of geology concerned with the study of earthquakes.

Seismometer : An instrument that records the intensity and duration of earthquakes and similar tremors. Strictly speaking seismograph is a term that refers to the seismometer and its recording device as a single unit.

Seismoscope : An instrument indicating only the occurrence and time of an earthquake.

Seismic constant : In building codes dealing with earthquake hazards, an arbitrarily set quantity of steady acceleration in units of acceleration of gravity, that a building must withstand.

Seismic discontinuity : A surface at which velocities of seismic waves changes abruptly.

Shearing stress : A stress in which the material by one side of a surface such as a fault plane, pushes on the material on the other side of the surface with a force parallel to the surface.

Slip rate : The rate at which two sides of a fault are slipping relative to one another

Slip : The relative displacement of formerly adjacent points on opposite sides of a fault measured on the fault surface

Subduction : The process by which one crustal block descends beneath another.

Subduction zone : The place where two crustal blocks come together, one riding over the other.

Surface faulting : Displacement that reaches the Earth's surface during slip along a fault. Surface faulting normally occurs with shallow earthquakes.

Surface wave : Seismic waves that travel along the Earth's surface for example, Rayleigh and Love waves.

Tectonic : Designing of, or pertaining to changes in the structure of the Earth's crust, the forces responsible for such deformation or the external forms produced.

Teleseismic : Pertaining to earthquake at distances greater than 1,000km from the site of measurement.

Thrust fault : A dip-slip fault in which the upper block above the fault plane moves up and over the lower block.

Tsunami : A huge sea wave caused by a great disturbance under an ocean, as a strong earthquake or volcanic eruption.

Tectonics: A branch of geology that deals with the Earth's crustal structure and the forces that produce changes in it.

Tsunamigenic : Referring to those earthquakes, that can generate tsunamis.

Tsunami magnitude : A number that is used to compare sizes of tsunamis generated by different earthquakes.

Alfred Lothar Wegener (1880-1930) was born in Berlin and he was educated at the universities of Heidelberg, Innsbruck and Berlin. He obtained his PhD in planetary astronomy. However, he became interested in the developing fields of meteorology and climatology.

In 1906 he went on his first meteorological research trip to Greenland. Subsequently he participated in several meteorologic expeditions to Greenland. In 1908 he was appointed to a lectureships in astronomy and meteorology at the University of Marburg. In 1914 he was drafted into the German army but was released from combat duty after being wounded. During the War he served in the army weather forecasting service. After the first World War he moved to a special chair of meteorology and geophysics at the University of Graz, Austria in 1924.

In 1915 Wegener produced his famous work, *Die Enstehung der Kontiente und Ozeane* which was translated in 1924 as *Origin of Continents and Oceans*. In this book he formulated his hypothesis of continental drifts. He proposed that the continents were once contiguous, forming one supercontinent, Panagea, which began to break up during the Mesozoic Era and drifted apart to form the continents we know today.

The idea of his theory of continental drifts occurred to him in 1911 when he came across a scientific paper that documented fossils of identical plants and animals found on opposite sides of the Atlantic. He started looking for similar organisms separated by great oceans. At that time scientists explained such cases by assuming that once land bridges existed which connected far flung continents. But then Wegener observed close fit between the coastlines of Africa and South America. This prompted Wegener to speculate that perhaps the continents were once joined together. In support of his theory he produced the following four main arguments.

- The obvious correspondence between such opposite shores as those of Atlantic Africa and Latin America.
- Geodetic measurements indicated that Greenland was moving away from Europe.
- A large portion of the Earth's crust is at two separate levels, the continental and the ocean floor and that the crust is made of the lighter granite floating on a heavier basalt.
- There were patterns of similarities between species of the flora and fauna of the continents. Wegener also observed that the fossils found in a certain place often indicated a climate utterly different from the climate of today.

Wegener's theory first met with considerable hostility, often exceptionally harsh and scathing . Wegener's theory found more scattered support after his death but majority of geologists continued to believe in static continent and land bridges. However, finally with the advances in geomagnetism and oceanography led to the full acceptance of Wegener's theory and the creation of the new discipline of plate tectonics after World War II.

Charles Francis Richter (1900-85) was born in Hamilton, Ohio, USA. He was educated at the Universities of Southern California and Stanford and the California Institute of Technology. In 1928 he obtained his PhD from the California Institute of Technology (Caltech). Richter was a professor of seismology at the Seismological Laboratory at the California Institute of Technology from 1936 to 1976. Once being asked that how he became interested in seismology Richter told : "It was really a happy accident. At Caltech, I was working on my PhD in theoretical physics under Dr. Robert Millikan. One day he called me into his office and said that the Seismological Laboratory was looking for a physicist; this was not my line, but was I at all interested? I talked with Harry Wood who was in charge of the lab; and as a result, I joined his staff in 1927".

Charles Richter

Richter developed his scale in 1935 to measure the strength of earthquakes. Earlier scales developed by de Rossi (1880s) and Giuseppe Mercalli (1902) used a descriptive scale defined in terms of damage to buildings and the behaviour and response of the population. So these scales could be used only in populated areas. This restriction made the scales relative to the type of building techniques and materials used. Richter wanted to devise a means of assessing them on an objective, quantitative basis rather than relying on subjective, descriptive methodology. With this view Richter was tabulating over 200 earthquakes a year in Southern California during the 1930s. The scale originally formulated was a local magnitude scale to assess the size of earthquake occurring in the Southern California. Today the scale in its modified form is used to measure earthquake worldwide. In 1954 Richter and Beno Gutenberg (1884-1960) produced one of the basic textbooks on seismology, *Seismicity of the Earth*. Richter loved to educate people about earthquake.

John Tuzo Wilson (1908-93) was born in Ottawa, Canada. He was educated at the Universities of Toronto and Princeton. He was the first student in Canada to study geophysics. He worked for the Geological Survey of Canada during (1936-39) and then spent seven years in the army. He taught geophysics at the University of Toronto during 1946-74. He played a pioneering role in establishing the new discipline of plate tectonics during the early 1960s. Wilson was the first to use the term 'plate' to refer to the rigid portions into which the Earth's crust is divided. In 1963 by pointing out that the further away an island lay from the mid-ocean ridge the older it proved to be, Wilson provided the earliest available evidence in support of the sea-floor spreading hypothesis postulated by Harry Hammond Hess (1906-69). Hess proposed this hypothesis in his important paper *History of Ocean Basins*(1962). Wilson in his paper titled *A New Class of Faults and their Bearing on continental Drift* and publish in 1965 introduced the idea of a transform fault where the plates slide past each other without any creation or destruction of material. His book, *A Revolution in Earth Science*, was published in 1967.

• • •

Form IV-E

Details of the ownership and other facts relating to monthly newsletter 'DREAM 2047'.

Place of Publication	: New Delhi
Periodicity of Publication	: Monthly
Name of the Publisher&the Printer (on behalf of Vigyan Prasar)	: Dr. Subodh Mahanti
Nationality	: Indian
Address	: Vigyan Prasar C-24, Qutab Institutional Area, New Delhi-110016
Name of the Editor	: Dr. V.B. Kamble
Nationality	: Indian
Address	: Vigyan Prasar C-24, Qutab Institutional Area, New Delhi-110016
Name & Address of the owner	: Vigyan Prasar C-24, Qutab Institutional Area, New Delhi-110016

I, Subodh Mahanti do hereby declare that to the best of my knowledge and belief, facts mentioned above are true.

(Sd) Subodh Mahanti

(Signature of the Publisher)

HOMI BHABHA CENTRE FOR SCIENCE EDUCATION

Homi Bhabha Centre for Science Education, established in July 1974 and supported by DAE as part of TIFR since 1981 in now a National Centre of TIFR, devoted to R&D work in science & mathematics education from primary to introductory college level. The broad goals of the Centre are to promote equity and excellence in science and mathematics education and encourage the growth of scientific temper in the country. To these ends it carries out a wide spectrum of interrelated activities, as described briefly here.


A view of the main building of the
Home Bhabha Centre for Science Education

HBCSE focuses on four important areas of work in its drive for equity. First, since a great majority of schools in the country have ill-equipped (or non existent) laboratories, an innovative low-cost school science and mathematics laboratory is under continual development at the Centre. Second, since mathematics is major cause of failure among the disadvantaged, it focuses on developing remedial techniques in mathematics pedagogy. Third, since language is basic to cognition of science, it emphasizes simplification of the language of science, explication of technical terms of science, etc. Fourth, the general issues surrounding equity : gender, health, cognitive and affective aspects of learning receive special attention in all of HBCSE's work.

These features of the Centre's work have evolved from and feed into a number of notable grassroots projects carried out by the Centre since its inception. Important among these is a Language Simplification Project, a pilot project for disadvantaged students from Municipal Schools of Mumbai and more recently, a Tribal Education Project involving the residential tribal schools in some districts of Maharashtra. Several books/reports on these themes have been brought out for wider dissemination. The low-cost (portable) HBCSE laboratory is used in workshops for teachers and students held in different parts of the country.

From its rich field experience and research on cognitive and related issues has emerged the Centre's most ambitious programme : development of an alternative curriculum in school science and mathematics (especially at the primary and middle levels) that is good and wholesome for all, but is especially sensitive to the problems of the disadvantaged. The alternative Class III book (science) developed by HBCSE is now ready for field trials and several other books are in different stages of completion.

Another notable effort of the Centre is the development of an activity-based Foundation Curriculum in Science, Technology and Society for post-school students. This is an issue-based interdisciplinary curriculum aimed at preparing citizens for coping with the complex demands of a modern technological society. A series of 8 books has been brought out to give a concrete shape to this novel conception.

HBCSE has also contributed substantially to text-book writing in science both at the State and National levels from primary to senior secondary stages, and to the innovative mathematics materials brought out by IGNOU.

HBCSE is the country's premier Centre for teacher orientation in science and mathematics from primary to senior secondary level. It also orients teacher education. The Centre has strong collaborative programmes with national networks of schools, especially that of the Atomic Energy Education Society. Collaborations are emerging with Bharatiya Vidya Bhavan. National Council of Teacher Education and several other organization. Creating popular awareness of science and mathematics, its methods, history and current frontiers and its linkages with the society is an important area of the Centre's work. A new initiative of the Centre is to focus on History of Science. A comprehensive (portable) exhibition on the theme has been developed by HBCSE for disseminating a developmental view of science among students. Promoting awareness of health, nutrition and diseases is another important aspect of the centre's work. Several books aimed at popularizing science and mathematics have been brought out. Encouraging excellence in science and mathematics, particularly at the senior secondary stage, is a major objective of the Centre. For 13 years, the centre ran a weekly study circle for promising physics undergraduates. Advanced laboratories in chemistry, biology and physics have been set up at the Centre for orientation of teachers and students at post-school level.

The Centre has now a National Science Olympiad Programme covering Mathematics, Physics, Chemistry and Biology with active support of DST, DAE and MHRD. The Chemistry Olympiad team participated for the first time in 1999 in the International Chemistry Olympiad at Bangkok, Thailand.

and won 2 silver and 2 bronze medals. The Biology team for the first time participated in International Biology Olympiad in year 2000 and won one silver and three bronze medals. In the same year in chemistry olympiad the team won 2 silver and 2 bronze medals. Now the centre is hosting International Chemistry Olympiad in 2001.

Despite its wide-ranging outreach activities, HBCSE is fundamentally an institute for research & development in the area of science and mathematics education. It lays great emphasis on research & contemporary scholarship to ensure quality and high professional standard of its work. HBCSE's research work has been part of the global effort in investigating congnitive and related aspects of learning and students' misconceptions in science. The Centre has carried out significant studies on effect of language simplification, picture comprehension in non-formal education and remedial measures for scholastic improvement of the disadvantaged students.

Olympiad Training Laboratory HBCSE

With its emphasis both on research and grassroots experience, content and method, equity and excellence, HBCSE aspires to have a lasting impact on the science and mathematics education in the country.

HBSCE was given the National award for best efforts in Science Popularisation among children for the year 1999, by National Council for Science & Technology Commounication, New Delhi.

(Based on the information supplied by the Centre)

Letters to the Editor

I have enjoyed the article on Sir William Herschel (published in November 2000 issue of 'Dream 2047'). In this connection, I would like to mention that Sir M.J. Herschel, grandson of Sir William Herschel, served for sometime as District and Session Judge of Nadia, a district in Bengal. He inspired and guided Mr. Kalnath Mukherjee, a lawyer by profession, to study astronomy. Later Mr. Mukherjee wrote a book named 'Popular Hindu Astronomy' (published in 1905) which he dedicated to his mentor Sir M.J. Herschel. In the 'Foreword' of 1969 edition of this book. N.C. Lahiri (famous for Lahiri's almanac) has written following lines about the author of the book as well as Sir M.J. Herschel.

DEDICATED
(With his permission)
TO
Sir M. J. Herschel, Bart., M.A.,
Sometime District and Sessions Judge of Nadia, Bengal
As Humble Tribute of Gratitude for his inspiring a number of Under-graduates of the Krishnagar College
WITH LOVE FOR THE STARS
BY
One of them
THE AUTHOR

"Born in a middle class Brahmin family at Jaidia in Jessore district, now in East Pakistan, the author had college education at Krishnanagar... He graduated with honours in the year 1872 with Mathematics, Philosophy' and Sanskrit. He then studied law and got the degree in 1873. While he was a student at Krishnanagar College, he came in contact with Sir M.J. Herschel, M.A.,Bar-at-Law and also an astronomer who was the grandson of Sir William Herschel, the great astronomer. The author had the privilege of getting considerable inspiration and guidance from Sir M.J. Herschel in the study of astronomy and the stars. As a mark of tribute and respect he dedicated the present book to his precceptor." A copy of the page which shows that the book was dedicated to Sir M.J. Herschel is also attached herewith in support of the above statement.

Utpal Mukhopadhyay, Asstt. Teacher, Barast Satyabharati Vidyapith, Mark 24 Paraganas, West Bengal

I was impressed by your publication "Dream - 2047". The December issue is very informative, particularly for molecular biology. I would like to receive your publications. Also, please let me have the first issue. I would like to point out a few errors and omissions in your Dec. 2000 issue in connection with Dr. S. Mahanti's article On the Origins and Development of Molecular Biology. • 1950 : Chargaff found that the number of A is equal to T, and that of G is equal to C. A cannot be equal to G, and C to T, as they do not base pair. • 1958 : Structure of an RNA (tRNA) was determined by Robert Holley. Got Nobel Prize along with Nirenberg and Khorana in 1968. • 1970 : It is HindIII, not HindII. Only the 1st letter is capital, the rest (ind) are small. •1973 : Paul Berg received Nobel Prize for making recombinant DNA. • 1985 : It is Jeffrey, not Joffrey. • 1967 : Without Werner Arber's (Switzerland) discovery of restriction enzymes in 1968, there would have been no genetic engineering. He got Nobel Prize along with H.O. Smith and Nathans in 1978. • Many whom the author has listed were awarded Nobel Prize, but he has mentioned only a few. It would be nice to mention all those who got the prize. • Moreover, in Dec. 2000 the DNA sequence of human chromosome 22 was published. I congratulate you for promoting science. *(P.S. I teach Molecular Biology).*
With all good wishes.)

Professor M.S. Kanungo, Emeritus professor, Biochem & Molec. Biology, Department of Zoology, BHU, Varanasi - 221 005

The November issue of "Dream - 2047" has been quite impressive. I am glad to read Editorial Column, Frederick William Herschel and VP News in this issue.

Narottam Rabha, Madhyampur Janajati, M.E. School, P.O. Dhup guri, Dist - Golaghat, Pin - 785601

I am congratulating you and your staff for regularly bringing out the monthly newsletter of Vigyan Prasar entitled "Dream -2047" . The Editorial column and the rise of F.W.Herschel written by Subodh Mahanti gave me many new ideas and some instinctive points came to my mind. I have been really benefitted a lot from the most influential working astronomer of 18th century.

H.H. Mate, H.M. Higher Secondary School, Keithelmanbi, Military Colony, Sadar Hills, Manipur

I have received the issues from August to November and instantly read them all. Being a bilingual magazine, it has attracted attention of my young kids. However, they expect the magazine to include basic scientific articles also. It would be wonderful if the Hindi version is called "Swapna 2047".

Binod Kumar Jha, C-81, ONGC Colony, NAZIRA - 785 685, Assam

Vigyan Prasar Publications

Science Biographies
Memoirs of Ruchi Ran Sahni
Editors: Narender K. Sehgal and
Subodh Mahanti
ISBN: 81-7480-016-6
pp: 264+xxxvi, Rs. 60

Science Classics Reprints
The Chemical History of a candle
Michael Faraday
ISBN:81-7480-002-6
pp:146+xx, Rs. 35

Soap Bubbles and the Forces which Mould Them
C.V. Boys
ISBN:81-7480-001-8
pp: 109+xiv, Rs. 30

My Friend Mr. Leakey
J.B.S. Haldane
ISBN: 81-7480-029-8
pp: 145+xxx, Rs. 40

Everything has a history
J.B.S. Haldane
ISBN: 81-7480-031-x
pp:165+xxiii, Rs. 45

Eclipse Series
Myths & Legends related to Eclipses
N.C. Rana
ISBN: 81-7480-006-9
pp:61, Rs. 21

Total Solar Eclipse Answers to all your questions
Narender K. Sehgal &
Sandip Bhattacharya
ISBN: 81-7480-007-7
pp: 37, Rs. 12

Rahu Ketu ki khoj
Rakesh Popli
ISBN: 81-7480-009-3
pp: 34, Rs. 12

Khoya Hua Janam Din
Rakesh Popli
ISBN: 81-7480-008-5
pp: 56, Rs. 20

Akash Darshan ka Anand
Rakesh Popli
ISBN: 81-7480-010-7
pp: 75, Rs. 25

Children's Series
Kahani Maap-Tol ki
Baldev Raj Davar
ISBN: 81-7272-010-6
pp:45, Rs. 20

Health Series
Understanding Asthma
Dr. S.K. Sharma
ISBN: 81-7480-012-3
pp:72, Rs. 34

Know More about Jaundice
Dr. R.S.K. Sinha
ISBN: 81-7480-015-x
pp: 58, Rs. 31

Sex, Sexually Transmitted Diseases and AIDS
Dr. R.S. Misra
ISBN: 81-7480-013-1
pp:152, Rs. 65

NCSTC-Hornbill Natural History Series
Extinction is forever
J.C. Daniel
ISBN: 81-7480-022-0
pp: 64+xii, Rs. 125

Diversity - the cornerstone of life
Madhav Gadgil
ISBN: 81-7480-026-3
pp: 64+xii, Rs. 125

Predators and Prey - nature strikes a balance
K. Ullas Karanth
ISBN: 81-7480-025-5
pp: 64+xii, Rs. 125

Moths of India - an introduction
Isaac Kehimkar
ISBN: 81-7480-027-1
pp:64+xii, Rs. 125

The Indian Elephant - endangered in the land of Lord Ganesha
Ajay Desai
ISBN: 81-7480-024-7
pp: 65+xii, Rs. 125

Evolution - the story of life
Renee Borges
ISBN: 81-7480-023-9
pp: 65+xii, Rs. 125

India's Scientific haritage series
The Rustless Wonder
a study of the Iron Pillar at Delhi
T.R. Anatharaman
ISBN: 81-7480-015-8
pp: 141+xviii, Rs. 350

Environmental Hot spots
Tehri Hydro Electric Project
Narmada Valley Project
Jagdish Bahadur
ISBN: 81-7480-043-3
pp: 138, Rs. 125

Other Publication
Kyon Aur Kaise?
Partha Ghose, Dipankar Home &
Narender K. Sehgal
ISBN: 81-7480-019-0
pp: 113, Rs. 149

Mad. Mad. Mad Cow an overview of the Mad Cow Disease
Kunal B. Roy and Santosh K. Kar
ISBN: 81-7480-020-4
pp: 111+xxi, Rs. 99 (HB) Rs. 54 (PB)

Vigyan Lokpriyakaran : Prarambhik Prayas
Editors: Shivgopal Mishra and
Dinesh Mani
ISBN: 81-7480-021-2
pp: 197+xxv, Rs. 95

Paramanu se Sitaron Tak
Adhunik Vigyan ke Tathya aur Kalpnayae
Rakesh Popli
ISBN: 81-7480-038-7
pp: 279+xx, Rs. 99

Other Publications
Delhi's Water and Solid Waste
S.K. Rohilla, S.P. Bansal and P.S. Dutta
ISBN: 81-7480-052-2
pp: 92, Rs. 100

Development and Valuation of Urban Properties:
P.K. Ratho
ISBN: 81-7480-032-8
pp:420+xxii, Rs. 250

Alternatives to Pasticides in Tropical Countries
A.T. Dudani
ISBN: 81-7480-047-6 (HB)
ISBN: 81-7480-051-4 (PB)
pp:360+xvi, Rs. 250 (HB),Rs. 150 (PB)

Uncharted Terains
Narender K. Sehgal, Satpal Sangwan & Subodh Mahanti
ISBN: 81-7480-056-5
pp:158+xvi, Rs. 150

Square Pegs in Round Holes
Ravindra Keshar
ISBN: 81-7480-048-4
pp:71+x, Rs. 50