

tific evaluation of some herbal medicines mentioned in ayurveda. According to K. Ohigashi, Asia is rich in plants with anti-cancer phytochemicals. Traditional Indian spices are health promoting, says Kamala Krishnaswamy, quoting work done on turmeric and fenugreek – the former an anticarcinogen and the latter anti-diabetic.

But then food is not the only thing. If you want to age with grace, and be in good health, not only must you eat plant foods (rich in nutraceuticals) and fish (rich in Omega-3 fatty acids) but you must also perform regular strength-training exercises, advises Mark Wahlquist, on the basis of global studies.

Apart from Omega-3 fatty acids, the micronutrient that has hogged attention in recent years is vitamin A. Besides its known role in vision, it has been prescribed as the magic nutrient to promote growth, reproduction and more recently to prevent morbidity, and mortality. However, a recent study from Tanzania (W. Fawzi and A. Chatterji) cautions against administering vitamin A to pregnant women suffering from HIV infection, because it was found to increase the mother-to-child transmission of HIV infection.

One of the less recognized nutritional deficiencies is zinc deficiency. While clinical deficiency may not be rampant, it does have functional impact in terms of cell-mediated immunity (A. S. Prasad) and cognitive performance (H. H. Sandstead) among other effects related to growth and differentiation. Beneficial effect of zinc supplementation in respiratory infections in Indian children was reported by M. K. Bhan and in cholera and diarrhoea in children of Bangladesh

by S. K. Roy. An important question pertains to micronutrient requirement in infections. Infections like respiratory infections lead to increased urinary loss of some of the most limiting nutrients like vitamin A and riboflavin due to altered metabolism and impaired utilization (M. Bamji). Should nutrients be poured in a leaky pot?

Besides nutrients, probiotics (right cocktail of micro organisms to colonize intestines) can play an important role in prevention as well as treatment of intestinal disorders. The symposium 'Probiotics in disease management' explored this role.

Major micronutrient deficiencies like iron deficiency anaemia, iodine deficiency diseases, and vitamin A deficiency which continue to be public health problems were discussed, the thrust being on strategies and programmes for their prevention. Dietary approach was stressed. Despite abundant sunlight, Indians do show evidence of vitamin D and calcium deficiency, according to Kochupillai. The question of calcium requirement and deficiency needs greater attention, because calcium deficiency hits the children (stunting) and the elderly (osteoporosis and osteomalacia). Ann Prentice brought out the current concepts and controversies in this regard. Nutrition problems of infants, children, adolescents and elderly, were all discussed by experts.

Among the strategies for preventing micronutrient deficiencies, home gardening and food fortification were discussed in separate symposia. The latter is receiving considerable attention in India despite the problem of bioavailability and limited choice of food items that can be

fortified. But ultimately there has to be community-based approach for household food security and nutrition well being. The experience of Bangladesh in home gardening is noteworthy (A. Talukdar). FAO's programmes in promoting household food security and nutrition were discussed by B. Nandi.

Food technology coupled with food safety are needed not only for promoting nutrition security but also for economic prosperity. India needs to improve its performance on both the fronts. There has to be greater interaction of nutritionists with industry, to enable food industry to contribute towards nutrition security. Food safety evaluation using the HACCP approach is needed from street foods to export-quality processed foods.

Good research demands state-of-the-art technology. Research using stable isotopes has not only helped to objectively assess the problem of malnutrition as well as degenerative diseases, but has also contributed to its prevention as seen from some of the international studies sponsored by the International Atomic Energy Agency.

The very well-organized IX Asian Congress of Nutrition was scientifically stimulating and provided food for thought for each country to evolve its own nutrition goals and strategies for achieving them.

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## Earth system processes related to Gujarat earthquake using space technology\*

An International Workshop on Earth System Processes Related to Gujarat Earthquake using Space Technology was

inaugurated by Vinod K. Gaur (Indian Institute of Astrophysics, Bangalore). He gave a talk on the 'Bhuj earthquake' and highlighted the Global Positioning System (GPS) results and their importance in understanding the dynamics of the Indian plate. This workshop was attended by 80 participants from various research and academic institutions in India.

Seven foreign scientists participated in the workshop from NASA (USA), Germany, Russia and China.

D. Bannert (UNESCO, GARS Program) presented a paper related to Indian-Eurasian collision in Pakistan; he pointed out that a number of basement faults developed within Indian plate during the collision. Presently these faults are con-

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nected with numerous seismic activities in the eastern Indian plate. The Dauki fault along the Shillong and Mikir Plateau strikes EW and shows right lateral offset while in the western part, NS-oriented left lateral basement fault developed. The flow direction of Gangetic plane suggests movement and tilting of these blocks.

H. B. Madhwal (Survey of India, Dehradun) presented detailed results based on a GPS survey made by the Survey of India. It was found that the area is rotating anticlockwise as a maximum shift of 11.1 m is observed at Lakhpat (Gujarat), while at other sites' shifts are found to be 1 to 5 m. However, the accuracy of measurements and time duration of data collection are the major factors affecting the results. Based on the gravity data, it was concluded that there is an upliftment between Ahmedabad and Rajkot while there is subsidence among Okha, Porbandar, Jodia, Mundra and Bhuj. The leveling observations made by the Survey of India show that SantalPur Bhuj Block uplifted up to 60 cm, while Bhuj, Bhachau, Mundra subsided by about 60 cm. The need to establish a dense network of level lines and gravity stations in Kachchh was stressed. V. K. Rao (NGRI, Hyderabad) presented a paper based on the geophysical data which shows strike slip movements, near Chaman faults. The direction of the strike slip reverses at 250 km east, Kachchh rift experiences extensional tectonic regime. The cause of upliftment in Kachchh in later phase is due to the effect of Makaran subduction via Karachi. He also added that the seismicity pattern in the plate of Kachchh suggests diffuse plate boundary near the Makran subduction.

A. K. Shukla (IMD, New Delhi) gave details about seismic observations being made by IMD and monitoring capabilities. The network of seismic observations until December 2002 has recorded more than 1000 aftershocks from Bhuj earthquake. The depth of focus of Bhuj earthquake was found to be 22.6 km and focal mechanism of strike-slip nature. The details of ongoing seismic activities around Bhavnagar and Jamnagar regions were also presented. V. M. Tiwari (NGRI, Hyderabad) presented a paper based on gravity and magnetic surveys. The gravity and magnetic studies have delineated a hidden thrust fault striking NW-SE direction thrust fault along the western margin of Wagad uplift near the epicentral region of Bhuj earthquake.

C. P. Rajendran (Centre for Earth Science Studies, Thiruvananthapuram) presented his studies on palaeo earthquakes/seismicity with dates. The morphological characteristics suggest that deformation due to 1819 Bhuj earthquake corresponds to a broad zone. The Bhuj earthquake exposed many fossil features related to other earthquakes. He has shown the relation of decollement zone with the rifting events in Bhuj region. He stressed the need for trenching at many places. George Mathew (PRL, Ahmedabad) has shown that several episodes of earth movements along the major E-W faults indicate the initial phase of incision (which began around the early Holocene) which continued until 5 ka along the major rivers north of Bhuj. Luminescence ages show the younging on age towards east of Bhuj. P. Mandal (NGRI, Hyderabad) found an east-west trending fault responsible for the main earthquake, using aftershock data. The aftershock zone confines to a 60 km × 40 km region lying between KMF and NWF. He showed the 1-D velocity model by inverting P and S waves travel time of 500 aftershocks. A high 6-value zone at 15-30 depth was found, indicating heterogeneity representative of high VP/VS and Poisson's ratio in Hypocentral zone.

Sushil Kumar (WIHG, Dehradun) presented tomography studies in collaboration with NGRI, Hyderabad and a few scientists from Japan, using aftershocks data of Bhuj earthquake. The tomography inversion was based on the inversion of 8374 P and 7994 S waves of 1404 aftershocks data recorded by 25 temporary seismic stations. The velocity model given by NGRI was used to construct 3-D tomographic inversion. This gave relatively high VP/VS and low VS in the region below the hypocentre of main shock. P. N. S. Roy (BHU, Varanasi) discussed the fractal analysis of tectonic map governing seismic activity in the region. He had shown low value of fractal dimension of Kachchh rift block in comparison to surrounding blocks. Numerous faults in clustered manner have been found in Kachchh rift.

R. V. Karanth (Baroda University) explained the structure and tectonic framework of Kachchh. He mentioned that the region forms a thin-skinned thrust belt with regularly spaced asymmetrical buckle folds to recumbent folds and break-thrust folds. He also mentioned

that the present epicenter lying at the eastern extreme of Kachchh mainland fault is progressively emerging upward.

B. K. Rastogi (NGRI, Hyderabad) discussed results about the deformation due to Bhuj earthquake and inferences about stress and strain in the Kachchh region. He mentioned that the large strain had to be due to some anomalous local cause. He explained that this earthquake had occurred along a hidden south-dipping fault at 25 km north of Kachchh Mainland Fault (KMF). He also described the obtained peak ground acceleration values around the epicentral zone using deterministic and probabilistic approaches.

R. N. Iyenger (IISc, Bangalore) presented attenuation relations for Kachchh obtained from peak ground acceleration values estimated from the assessment of structural damages near source region and the observed near-source ground motion data for 2001 Bhuj main shock.

B. K. Bhadra (ISRO, Jodhpur) presented a paper dealing with the importance of IRS PAN data in assessing the observed damages caused by the 2001 Bhuj earthquake. T. K. Biswal (IIT, Mumbai) drew attention towards the small-scale geological features which have resulted from the occurrence of 2001 Bhuj earthquake and this is based on remote sensing data. He suggested that these features might have been caused by left lateral shear movement along the mainland fault. R. Banerjee (SAC, Ahmedabad) presented the importance of satellite imageries in estimating probabilistic hazard values as well as the direction of maximum horizontal compressive stresses. A seismic zoning map of the Gujarat region was presented based on the estimated seismic hazard values suggesting PGA values varying from 0.4 to 1.0 g for the Kachchh region.

Arun Bapat (Pune) discussed details of observed seismic precursors prior to the Bhuj earthquake. Prior to Bhuj earthquake, upwelling of Kandla port and excessive sedimentation was observed. Other precursors based on newspaper reports were: (a) increase in frequency of micro-earthquakes during September 2000 to December 2000 at Bhavnagar and Porbandar, and (b) hydrological precursor—several wells in Gujarat and Rajasthan, which were dry for decades were suddenly filled with water during December 2000 to January 2001.

H. S. Virk (Gurunank Dev University, Amritsar) described the radon pre-

cursor signals observed at Palampur which is about 400 km from Chamoli and 1200 km from Bhuj where earthquakes occurred in 1997 and 2001, respectively. The radon anomaly was observed two days before the Chamoli main shock and four days prior to Bhuj earthquake of 26 January 2001 (before the main event). Virk established the efficacy of radon as an earthquake precursor. Mahesh Thakkar (Lallan College, Bhuj) explained the relation between magnitude and liquefaction dimensions near the epicentral zone. He mentioned that the present liquefaction database will be useful in assessing the magnitude of the older events. R. D. Deshpande (PRL, Ahmedabad) discussed observations on release of helium associated with Bhuj earthquake. He conducted a survey of naturally dissolved helium in groundwater, from the localities with typical high and low density of collapsed buildings.

D. Ramakrishnan (RRSSC-ISRO, Kharagpur) presented a paper based on detailed mapping of liquefaction in Bhuj and Bhachau areas using LISS-3 data, after initial evaluation of liquefaction using IRS-1C WiFS data. Attempt was made to derive band ratio to map liquefaction and test it for sensitivity with respect to field-based observations. It was shown that the proposed liquefaction sensitivity index (LSI) was sensitive enough to map the liquefaction.

Saumitra Mukherjee (JNU, New Delhi) presented a study based on correlation on the occurrence of global earthquake and earth-directed coronal mass ejection and change in magnetic field ( $Kp$  indices), and electron flux of earth-sun environment. A. Narain (SAC, Ahmedabad) presented an overview of application of space technology for disaster management. Various components such as mitigation, preparedness, warnings, response, recovery, relief, education and training were discussed.

Three papers related to changes in geomagnetic field behaviour prior to an earthquake were presented. J. R. Heirtzler (NASA, USA) gave a succinct account of the various geomagnetic field satellites in orbit or proposed during the decade of geopotential research. These satellites record ionospheric current systems and their perturbation. He presented geomagnetic data from present magnetic satellites which found a sizeable unexplained signal near a magnitude 8.4 earthquake. However, he cautioned that the

geomagnetic anomalies due to ionospheric sources/magnetospheric disturbances needed to be verified.

Mita Rajaram (IIG, Mumbai) presented maps showing magnetic, aeromagnetic, gravity satellite data, heat flow and emphasized the need to have good data coverage of different geophysical parameters for a good database. She presented results from ground magnetic, magnetovariational (MV), long magnetotelluric (LMT) and GPS data, derived by IIG, Mumbai over Bhuj. The LMT measurements carried out by IIG have revealed the presence of a conductor in depth range 10–17 km, which may be attributed to the presence of a fluid.

S. C. Mavrodiev (Bulgaria) presented the changes in geomagnetic field prior to Gujarat earthquake. He stated that the geomagnetic field combined with tidal wave and various geophysical data, could be used for early warning signals of an earthquake and also location of earthquakes.

Dimitar Ouzounov (NASA, USA) presented an interesting paper based on experiments on rock deformation in terms of rise in mid IR emission, surface potential and ion emission of a granite sample at a steady rise of uniaxial stress. He correlated the rise in land and sea surface temperature, chlorophyll content and ionic potential of the ionosphere before and after Bhuj and Iran earthquakes from the latest TERRA/MODIS satellite data. Javed Malik (IIT, Kanpur) dealt with active faults in Bhuj area based on satellite imagery. R. C. Jain (Central Ground Water Board, Ahmedabad) presented the detailed hydrogeologic study of the Bhuj area showing sharp increase in water level in all areas in Kachchh except in Rapar after the Bhuj earthquake. However, no rise in temperature or changes in groundwater quality were found in advance of Bhuj earthquake and significant changes of water level parameters after the event were found. R. P. Singh (IIT, Kanpur) presented the results of his study on the application of multi remote sensing sensors data for early warning of intraplate earthquake on the basis of increase in soil moisture content, land surface temperature, latent heat flux, chlorophyll concentration in ocean and water vapour in atmosphere.

Six papers dealing with ionospheric perturbations and monitoring of ionospheric signals were presented. The results presented by scientists from India,

Russia and Mexico have shown strong correlation of the changes in ionosphere and earthquake events. Scientists have also strong belief that the behaviour of aerosol and gravity waves changes significantly prior to an earthquake. Raj Pal Singh (Agra) has found ionospheric anomaly during Bhuj earthquake. A. K. Gwal (Bhopal University) presented ionospheric signatures as a precursor of earthquake. S. A. Pulinetz (Mexico) stressed the need for electric field measurement within the ionosphere over the seismically active areas.

During the meeting, a tutorial workshop presenting the latest NASA TERRA/MODIS satellite data was conducted by D. Ouzounov (NASA). The main topics of the workshop were data products and descriptions, data search and ordering, data tools and information on how to use some of the data products for the purpose of natural hazard studies. More than 25 scientists attended the course and all showed interest to become new MODIS users.

During the workshop, panel discussions on three different topics were organized. The panel discussion on 'Geology, tectonics and seismology: Future directions' was chaired by V. K. Gaur and the other members were D. Bannert, Wu Zhongliang (China), B. K. Rastogi (NGRI, India), R. V. Karanth (Baroda University, India), C. P. Rajendran and C. Sivaji (DST, India) who acted as Reporter of this panel discussion. The following recommendations were made:

- Detailed studies of rift valleys and intra cratonic structures be carried out for generating finer detailed geological maps.
- A few pilot projects may be formulated to understand associated parameters including geological/geochemical, surface temperature, heat flux and ionospheric parameters.
- Palaeo-seismological investigations should be initiated to understand past seismicity in a region and to upgrade earthquake catalogues.

A panel discussion on 'Natural and man-made hazards using space technology and international cooperation' was chaired by J. R. Heirtzler (NASA, USA). The other members were: D. Bannert, Dimitar Ouzounov (IAF), A. Narain (ISRO), R. P. Singh (COSPAR). M. Mohanty (DST, New Delhi) acted as Reporter of this panel discussion.

The following recommendations emerged after a detailed discussion among the participants and panel members on various issues of disaster mitigation.

- It was suggested that member countries may approach Disaster Management support group at ISRO, Bangalore for getting the Radarsat data for disaster management purpose.
- Reservoir-induced seismicity studies may be carried out in different dams located in high seismic zones in order to avoid dam disasters due to earthquake in the region where intraplate earthquakes are common.
- All the space agencies may discuss projects related to natural hazard management at an international level for technology solutions.
- Geomagnetic field satellites detect ionospheric current system fluctuations

whose origin is not yet fully understood. Weather fluctuations related to fluctuations associated with natural hazards need to be investigated.

A panel consisting of S. K. Jain (IIT, Kanpur), B. K. Rastogi (NGRI, Hyderabad) and R. N. Iyengar (IISc, Bangalore) discussed 'Seismic hazard of the country'. The following recommendations were made by the panel:

- Installation of more numbers of strong motion accelerographs and seismograph stations in the country for obtaining a better estimation of peak horizontal acceleration (PGA) value and attenuation relation.
- Preparation of a homogeneous and consistent catalogue of Indian earthquakes.
- Designing of attenuation relationships for different regions of the country.

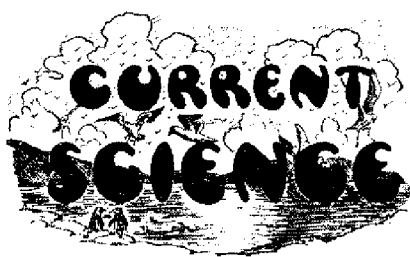
- Preparation of seismic hazard maps incorporating soil characteristics, liquefaction potential, site response and better attenuation relationships for corresponding regions.

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## FROM THE ARCHIVES



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### Dr. Rabindranath Tagore (1861–1941)

We deeply mourn the death of Rabindranath Tagore on Thursday the 7th August in his residence at Calcutta. He was a universal figure venerated all over the civilized world as a poet, a philosopher and a seer. He travelled far and wide, and in most cities of the world, surging crowds were held spell-bound by the melody of his voice, by the inspiration of his addresses and by the fullness of his love and sympathy. There is scarcely any language into which his more important verses have not been translated. No poet, ancient or modern, has received during his lifetime the honour and reverence with which Dr Tagore has been greeted both in the East and the West. Indeed Keyserling has aptly described him as the most encompassing human being ever known.

His literary achievement is prodigious. It overshadows everything else. His writings have influenced the cultural and spiritual life of Bengal as nothing else has done during the last fifty years. He is however essentially a lyrical poet; and his poems have a universal appeal for they are always the expressions of his unique personality. As he himself says, 'When our heart is fully awakened in love or in other great emotions, our personality is in its flood tide. Then it feels the longing to express itself. Then it is that the notes of our music and song try to fathom the depths of the ineffable'. Thus when *Gitanjali* was published in English translation in 1912, it was received with raptures that were almost bewildering. Maeterlinck thought that the passages in the book would rank among the loftiest, the most profound and most divinely human ever written. And he was soon awarded the Nobel Prize in Literature.

There are few people who now remember that in the first decade of this century, Rabindranath was an active participant in the rough and tumble of politics. His national songs were sung in almost every political demonstration that followed the partition of Bengal in 1905. His eloquent speeches in Bengali moved vast audiences to whom the English oratory of Surendranath Banerjee carried no meaning. He became a priest of the

National Revival and assailed foreign rule with increasing vehemence. He extolled the valour and self-reliance of the heroes of India in most exquisite ballads, which together with his national songs have become a priceless possession of the Bengali literature.

One cannot help recalling that Rajah Ram Mohan Roy, the father of modern Indian Renaissance, had Maharsi Devendranath Tagore as his foremost disciple and Rabindranath was the youngest son of that disciple. Rarely do we witness such a succession of greatness in the history of a country to mould the spiritual and national life of its people for more than a century. These were noble spirits who were called to surrender themselves to the quest for the Heaven of Truth and Freedom. When the chaos of the modern world would burn deep his sensitive soul, Rabindranath would sing:

*'Where knowledge is free,  
Where words come out from the depths  
of Truth,  
Where the clear stream of Reason has  
not lost its way into the desert sand of  
dead habit,  
Unto that Heaven of Truth and Freedom;  
my Father, let my country awake.'*

To readers of *Current Science*, what message could be more inspiring than the call to join this quest!