NEWS AND VIEWS AT A GLANCE

Forthcoming Conferences:

1) National Seminar on Mineral Resource: Geology, Eco-Friendly Mining and Utilization and Workshop on Role of Geologist in Urban Development—organised by Geoscientist Society of Rajasthan during 18-19 April-2015. For future details contact: Prof. P.C. Avadich, Secretary, Geoscientists Society of Rajasthan, MLSU Udaipur. **Phone**:91-9460574202; **Email**:geoschientistssocietyraj@gmail.com

2) 36th International Symposium on Remote Sensing of Environment, 11-15 May, Berlin, Germany. http:// www.isrse36.org

3) 13th South East Asian Survey Congress, 28-31 July, Singapore, www.seasc2015.org.sg

Awards and Recognitions:

- **Mangalyaan, Swacch Bharat Abhiyan Inspire Republic Day Performances**
  India's maiden Mars mission 'Mangalyaan' and 'Swachh Bharat Abhiyaan' are among the themes of the cultural performances at the Republic Day parade this year.

- **ISRO Mars Orbiter Mission Team Wins Space Pioneer Award**
  ISRO's Mars Mission team has won the prestigious 2015 Space Pioneer Award in the science and engineering category in recognition of achieving the rare feat in its very first attempt.
  ISRO was given the award by the US-based National Space Society (NSS) in the science and engineering category.

- **Padma Bhushan Award**
  Prof.K.S.Valdiya **,** renowned Geologist has been selected for Padma Bhushan Award.

Science News

We have introduced couple of years back Science News, as these articles while exposing the reader to new studies might enthuse young researchers in following precise methodologies adopted by scientists in looking at topics of interest. One can say any one can download these details from internet and as such what purpose do they serve. We do not deny details are available on internet. There is innumerable number of articles---an ocean of information. Many a time one may lose track and ends up confused. To avoid such a development we select such topics that we consider as unique and relevant from present day scenario and include in this subsection. Where ever necessary Editor`s Note is appended to stress the importance of the study, to draw the attention of interested reader. For this issue we have selected recent studies carried out by earth scientists to unravel hidden mysteries associated with Crust, Mantle and Core. We have also included some interesting articles on earthquakes. Since space science is both intriguing and exciting couple of articles have been added to the list. Hope they are of use to researchers pursuing research in different branches of earth system.

- **Ancient Earth crust stored in deep mantle**

Oceanic crust sinks into Earth's mantle at so-called subduction zones, where two plates come together. Much of what happens to the crust during this journey is unknown. Model-dependent studies for how long subducted material can exist in the mantle are uncertain and evidence of very old crust returning to Earth's surface via upwellings of magma has not been found until now. The research team studied volcanic rocks from the island of Mangaia in Polynesia's Cook Islands that contain iron sulfide inclusions within crystals. In-depth analysis of the chemical makeup of these samples yielded interesting results.

The research focused on isotopes of the element sulfur. (Isotopes are atoms of the same element with different numbers of neutrons.) The measurements, conducted by graduate student Rita Cabral, looked at three of the four naturally occurring isotopes of sulfur--isotopic masses 32, 33, and 34. The sulfur-33 isotopes showed evidence of a chemical interaction with UV radiation that stopped occurring in Earth's atmosphere about 2.45 billion years ago. It stopped after the Great Oxidation Event, a point in time when Earth's atmospheric oxygen levels skyrocketed as a consequence of oxygen-producing photosynthetic microbes. Prior to the Great Oxidation Event, the atmosphere lacked ozone. But once ozone was introduced, it started to absorb UV and shut down the process. This indicates that the sulfur comes from a deep mantle reservoir containing crustal material subducted before the Great Oxidation Event and preserved for over half the age of Earth. "These measurements place the first firm age estimates of recycled material in oceanic hotspots" Hauri said. "They confirm the cycling of sulfur from the atmosphere and oceans into mantle and ultimately back to the surface," Hauri said.

***(Source**: Rita A. Cabral, Matthew G. Jackson, Estelle F. Rose-Koga, Kenneth T. Koga, Martin J. Whitehouse, Michael A. Antonelli, James Farquhar, James M. D. Day, Erik H. Hauri. **Anomalous sulphur isotopes in plume lavas reveal deep mantle storage of Archaean crust**. Nature, 2013; 496 (7446): 490 DOI:10.1038/nature12020. **Courtesy**: The above write up is based on information provided by **Carnegie Institution**)*

- **Earth's dynamic interior: Multiple compositional components of Earth's deep mantle carried up to surface**

Mantle convection is the driving force behind continental drift and causes earthquakes and volcanoes on the surface. Through mantle convection, material from the lowermost part of Earth's mantle could be carried up to the surface, which offers insight into the composition of the deep Earth. Earth's core is very hot (~4000 K) and rocks at the core mantle boundary are heated and expanded to have a lower density. These hot rocks (also called mantle plumes) could migrate to the surface because of buoyancy. Observations, modeling and predictions have indicated that the deepest mantle is compositionally complex and continuously churning and changing. "The complex chemical signatures of hotspot basalts provide evidence that the composition of the lowermost part of Earth's mantle is different from other parts. The main question driving this research is how mantle plumes and different compositional components in Earth's mantle interact with each other, and how that interaction leads to the complex chemistry of hotspot basalts. The answer to this question is very important for us to understand the nature of mantle convection," explains lead author Mingming Li. "Obviously, we cannot go inside of Earth to see what is happening there. However, the process of mantle convection should comply with fundamental physics laws, such as conservation of mass, momentum and energy. What we have done is to simulate the process of mantle convection by solving the equations which controls the process of mantle convection," says Li.

It has long been suggested that Earth's mantle contains several different compositional reservoirs, including an ancient more-primitive reservoir at the lowermost mantle, recycled oceanic crust and depleted background mantle. The complex geochemistry of lava found at hotspots such as Hawaii is evidence of this. The various compositional components in hotspot lava may be derived from these different mantle reservoirs. The components could become embedded in and carried to the surface by mantle plumes, but it is unclear how individual plumes could successively sample each of these reservoirs. Joined by his advisor Allen McNamara, geodynamicist and associate professor in Arizona State University's School of Earth and Space Exploration, and seismologist and SESE professor Ed Garnero, Li and his collaborators' numerical experiments show that plumes can indeed carry a combination of different materials from several reservoirs. According to the simulations, some subducted

oceanic crust is entrained directly into mantle plumes, but a significant fraction of the crust -- up to 10 percent -- enters the more primitive reservoirs. As a result, mantle plumes entrain a variable combination of relatively young oceanic crust directly from the subducting slab, older oceanic crust that has been stirred with ancient more primitive material and background, depleted mantle. Cycling of oceanic crust through mantle reservoirs can therefore explain observations of different recycled oceanic crustal ages and explain the chemical complexity of hotspot lavas.

"Our calculations take a long time -- more than one month for one calculation -- but the results are worth it," says Li.

***(Source:** Mingming Li, Allen K. McNamara, Edward J. Garnero.* ***Chemical complexity of hotspots caused by cycling oceanic crust through mantle reservoirs**. Nature Geoscience, 2014; DOI: 10.1038/ngeo2120)*

Questions of continental crust

Geological processes shape the planet Earth and are in many ways essential to our planet's habitability for life. One important geological process is plate tectonics – the drifting, colliding and general movement of continental plates. This slow movement of mass has a role in causing all kinds of activity at the planet's surface, from earthquakes to the formation of mountains. A new review published by the Geological Society of London examines questions about the continental crust of Earth, which is the primary repository for information about Earth's geological history (as well as many natural resources of value to humankind). In the volume, scientists explore when and how continental crust formed and how it evolved through time. These are important questions for astrobiologists, and could provide clues about whether or not crustal formation is essential for the habitability of distant worlds.

*(**Source**:http://www.geologypage.com/2014/11/questions-of-continental-crust.html#ixzz3P9aeoYfr courtesy of NASA's Astrobiology Magazine. Explore the Earth and beyond at www.astrobio.net)*

- **Earthquakes: Water as a Lubricant**

Geophysicists from Potsdam have established a mode of action that can explain the irregular distribution of strong earthquakes at the San Andreas Fault in California. Reporting in the latest issue of the journal *Nature*, the scientists examined the electrical conductivity of the rocks at great depths, which is closely related to the water content within the rocks. From the pattern of electrical conductivity and seismic activity they were able to deduce that rock water acts as a lubricant. Los Angeles moves toward San Francisco at a pace of about six centimeters per year, because the Pacific plate with Los Angeles is moving northward, parallel to the North American plate which hosts San Francisco. But this is only the average value. In some areas, movement along the fault is almost continuous, while other segments are locked until they shift abruptly several meters against each other releasing energy in strong earthquakes. After the San Francisco earthquake of 1906, the plates had moved by six meters.

The San Andreas Fault acts like a seam in Earth, ranging through the entire crust and reaching into the mantle. Geophysicists from the GFZ German Research Centre for Geosciences have succeeded in imaging this interface to great depths and to establish a connection between processes at depth and events at surface. "When examining the image of the electrical conductivity, it becomes clear that rock water from depths of the upper mantle, i.e. between 20 to 40 km, can penetrate the shallow areas of the creeping section of the fault, while these fluids are detained in other areas beneath an impermeable layer," says Dr. Oliver Ritter of the GFZ. "A sliding of the plates is supported, where fluids can rise."

These results suggest that significant differences exist in the mechanical and material properties along the fault at depth. The so-called tremor signals, for instance, appear to be linked to areas

underneath the San Andreas Fault, where fluids are trapped. Tremors are low-frequency vibrations that are not associated with rupture processes as they are typical of normal earthquakes. These observations support the idea that fluids play an important role in the onset of earthquakes.

*(**Source**: http://www.geologypage.com/2011/12/earthquakes-water-aslubricant.htmlixzz3OzKRTc3g) Courtesy: Helmholtz Centre Potsdam - GFZ German Research Centre for Geosciences*

Editor`s Note:** The study is very significant as fault dynamics plays a significant role in genesis of earthquakes. Fluids do migrate from one place to the other and in this process introduce changes in the surrounding medium. Such a change can create imbalance and influence changes in the earth`s interior, especially in areas that are infested by a mesh of faults extending from surface to deeper depths. The information would be useful in understanding earthquake mechanism in different segments of Himalayas and in Andaman-Nicobar isles region.**

- **Stanford scientists identify mechanism that accelerated the 2011 Japan earthquake**

Stanford scientists have found evidence that sections of the fault responsible for the 9.0 magnitude Tohoku earthquake that devastated northern Japan in 2011 was relieving seismic stress at a gradually accelerating rate for years before the quake.This "decoupling" process, in which the edges of two tectonic plates that are frictionally locked together slowly became unstuck, transferred stress to adjacent sections that were still locked. As a result, the quake, which was the most powerful ever recorded to hit Japan, may have occurred earlier than it might have otherwise, said Andreas Mavrommatis, a graduate student in Stanford's School of Earth Sciences.

Mavrommatis and his advisor, Paul Segall, reached their conclusions after analyzing 15 years' worth of GPS measurements from the Japanese island of Honshu. "We looked at northeastern Japan, which has one of the densest and longest running high precision GPS networks in the world," Mavrommatis said.Segall said, "The measurements indicated the plate boundary was gradually becoming less locked over time. That was surprising." The pair's hypothesis is further supported by a recent analysis they conducted of so-called repeating earthquakes offshore of northern Honshu. The small quakes, which were typically magnitude 3 or 4, occurred along the entire length of the fault line, but each one occurred at the same spot every few years. Furthermore, many of them were repeating not at a constant but an accelerating rate, the scientists found. This acceleration would be expected if the fault were becoming less locked over time, because the decoupling process would have relieved pent-up stress along some sections of the fault but increased stress on adjacent sections.

"According to our model, the decoupling process would have had the effect of adding stress to the section of the fault that nucleated the Tohoku quake," Segall said. "We suspect this could have accelerated the occurrence of the earthquake." The scientists caution that their results cannot be used to predict the occurrence of the next major earthquake in Japan, but it could shed light on the physical processes that operate on faults that generate the world's largest quakes.

Reference: *Andreas P. Mavrommatis, Paul Segall, Kaj M. Johnson. A decadal-scale deformation transient prior to the 2011Mw9.0 Tohoku-oki earthquake. Geophysical Research Letters, 2014; DOI: 10.1002/2014GL060139.*

- **Fracking confirmed as cause of rare 'felt' earthquake in Ohio**

A new study links the March 2014 earthquakes in Poland Township, Ohio to hydraulic fracturing that activated a previously unknown fault. The induced seismic sequence included a rare felt earthquake of magnitude 3.0, according to research published online by the Bulletin of the Seismological Society of America (BSSA).

In March 2014, a series of five recorded earthquakes, ranging from magnitude 2.1 to 3.0, occurred within one kilometer (0.6 miles) of a group of oil and gas wells operated by Hilcorp Energy, which was conducting active hydraulic fracturing operations at the time. Due to the proximity of a magnitude 3.0 event near a well, the Ohio Department of Natural Resources (ODNR) halted operations at the Hilcorp well on March 10, 2014. Hydraulic fracturing, or fracking, is a method for extracting gas and oil from shale rock by injecting a high-pressure water mixture directed at the rock to release the oil and gas trapped inside. The process of fracturing the rocks normally results in micro-earthquakes much smaller than humans can feel. It remains rare for hydraulic fracturing to cause larger earthquakes that are felt by humans. However, due to seismic monitoring advances and the increasing popularity of hydraulic fracturing to recover hydrocarbons, the number of earthquakes - felt and unfelt - associated with hydraulic fracturing has increased in the past decade. "These earthquakes near Poland Township occurred in the Precambrian basement, a very old layer of rock where there are likely to be many pre-existing faults," said Robert Skoumal who co-authored the study with Michael Brudzinski and Brian Currie at Miami University in Ohio. "This activity did not create a new fault, rather it activated one that we didn't know about prior to the seismic activity." Using a technique called template matching, the researchers sifted through seismic data recorded by the Earthscope Transportable Array, a network of seismic stations, looking for repeating signals similar to the known Poland Township earthquakes, which were treated like seismic "fingerprints." They identified 77 earthquakes with magnitudes from 1.0 and 3.0 that occurred between March 4 and 12 in the Poland Township area. The local community reported feeling only one earthquake, the magnitude 3.0, on March 10. Skoumal and his colleagues compared the identified earthquakes to well stimulation reports, released in August 2014 by the ODNR, and found the earthquakes coincided temporally and spatially with hydraulic fracturing at specific stages of the stimulation. The seismic activity outlined a roughly vertical, east-west oriented fault within one kilometer of the well. Industry activities at other nearby wells produced no seismicity, suggesting to the authors that the fault is limited in extent.

"Because earthquakes were identified at only the northeastern extent of the operation, it appears that a relatively small portion of the operation is responsible for the events," said Skoumal, who suggests the template matching technique offers a cost-effective and reliable means to monitor seismicity induced by hydraulic fracturing operations."We just don't know where all the faults are located," said Skoumal. "It makes sense to have close cooperation among government, industry and the scientific community as hydraulic fracturing operations expand in areas where there's the potential for unknown pre-existing faults." The paper, "Earthquakes Induced by Hydraulic fracturing in Poland Township, Ohio," was published online Jan. 6, 2015 and in print in the February/March issue of BSSA.

*(**Source:** http://www.geologypage.com/2015/01/fracking-confirmed-as-cause-of-rare.html#ixzz3OzQ118vl)*

Editor`s Note: This study is important as there is a concerted effort to extract shale gas, using high pressure fracking. As fracking can affect the environment in different ways it is advised to take all precautions before going for this activity in different parts of our country. Interested can go through couple of articles and editorials published in JIGU.

- **GEOPHYSICISTS FIND THE CRUSTY CULPRITS BEHIND SUDDEN TECTONIC PLATE MOVEMENTS**

A new study published Jan. 19, 2015 in the journal *Proceedings of the National Academy of Sciences* says the answer comes down to two things: thick crustal plugs and weakened mineral grains. Those effects, acting together, may explain a range of relatively speedy moves among tectonic plates around the world, from Hawaii to East Timor. Of

course, in this case "speedy" still means a million years or longer. "Our planet is probably most distinctly marked by the fact that it has plate tectonics," said Yale geophysicist David Bercovici, lead author of the research. "Our work here looks at the evolution of plate tectonics. How and why do plates change directions over time?" Traditionally, scientists believed that all tectonic plates are pulled by subducting slabs -- which result from the colder, top boundary layer of the Earth's rocky surface becoming heavy and sinking slowly into the deeper mantle. Yet that process does not account for sudden plate shifts. Such abrupt movement requires that slabs detach from their plates, but doing this quickly is difficult since the slabs should be too cold and stiff to detach. According to the Yale study, there are additional factors at work. Thick crust from continents or oceanic plateaux is swept into the subduction zone, plugging it up and prompting the slab to break off. The detachment process is then accelerated when mineral grains in the necking slab start to shrink, causing the slab to weaken rapidly. The result is tectonic plates that abruptly shift horizontally, or continents suddenly bobbing up. "Understanding this helps us understand how the tectonic plates change through the Earth's history," Bercovici said. "It adds to our knowledge of the evolution of our planet, including its climate and biosphere."

***(Source**: www.sciencedaily.com/releases/2015/ 01/ 150119154507.htm).*

- **How did the universe begin? Hot Big Bang or slow thaw?**

Cosmologists usually call the birth of the universe the Big Bang. The closer we approach the Big Bang in time, the stronger the geometry of space and time curves. Physicists call this a singularity -- a term describing conditions whose physical laws are not defined. In the Big Bang scenario, the spacetime curvature becomes infinitely large. Shortly after the Big Bang, the universe was extremely hot and dense. Prof. Wetterich believes, however, that a different "picture" is also possible. If the masses of all elementary particles grow heavier over time and gravitational force weakens, the universe could have also had a very cold, slow start. In that view, the universe always existed and its earliest state was virtually static, with the Big Bang stretching over an infinitely long time in the past. The scientist from the Institute for Theoretical Physics assumes that the earliest "events" that are indirectly observable today came to pass 50 trillion years ago, and not in the billionth of a billionth of a billionth of a second after the Big Bang. "There is no longer a singularity in this new picture of the cosmos," says Prof. Wetterich. His theoretical model explains dark energy and the early "inflationary universe" with a single scalar field that changes with time, with all masses increasing with the value of this field. "It's reminiscent of the Higgs boson recently discovered in Geneva. This elementary particle confirmed the physicists' assumption that particle masses do indeed depend on field values and are therefore variable," explains the Heidelberg scientist. In Wetterich's approach, all masses are proportional to the value of the so-called cosmon field, which increases in the course of cosmological evolution. "The natural conclusion of this model is a picture of a universe that evolved very slowly from an extremely cold state, shrinking over extended periods of time instead of expanding," explains Prof. Wetterich. Wetterich stresses that this in no way renders the previous view of the Big Bang "invalid," however. "Physicists are accustomed to describing observed phenomena using different pictures." Light, for example, can be depicted as particles and as a wave. Similarly, his model can be seen as a picture equivalent to the Big Bang. "This is very useful for many practical predictions on the consequences that arise from this new theoretical approach. However, describing the 'birth' of the universe without a singularity does offer a number of advantages," emphasises Prof. Wetterich. "And in the new model, the nagging dilemma of 'there must have been something before the Big Bang' is no longer an issue."

***Reference**: C. Wetterich. **Variable gravity Universe**. Physical Review D, 2014; 89 (2) DOI:10.1103/PhysRevD.89.024005*
C. Wetterich. **Universe without expansion**. *Physics of the Dark Universe*, 2013; 2 (4): 184 DOI: 10.1016/j.dark.2013.10.002

- **Gravity may have saved the universe after the Big Bang, say researchers**

New research by a team of European physicists could explain why the universe did not collapse immediately after the Big Bang. Studies of the Higgs particle -- discovered at CERN in 2012 and responsible for giving mass to all particles -- have suggested that the production of Higgs particles during the accelerating expansion of the very early universe (inflation) should have led to instability and collapse. Scientists have been trying to find out why this didn't happen, leading to theories that there must be some new physics that will help explain the origins of the universe that has not yet been discovered. Physicists from Imperial College London, and the Universities of Copenhagen and Helsinki, however, believe there is a simpler explanation. In a new study in *Physical Review Letters*, the team describes how the space-time curvature -- in effect, gravity -- provided the stability needed for the universe to survive expansion in that early period. The team investigated the interaction between the Higgs particles and gravity, taking into account how it would vary with energy. They show that even a small interaction would have been enough to stabilise the universe against decay. "The Standard Model of particle physics, which scientists use to explain elementary particles and their interactions, has so far not provided an answer to why the universe did not collapse following the Big Bang," explains Professor Arttu Rajantie, from the Department of Physics at Imperial College London. "Our research investigates the last unknown parameter in the Standard Model -- the interaction between the Higgs particle and gravity. This parameter cannot be measured in particle accelerator experiments, but it has a big effect on the Higgs instability during inflation. Even a relatively small value is enough to explain the survival of the universe without any new physics!"

The team plans to continue their research using cosmological observations to look at this interaction in more detail and explain what effect it would have had on the development of the early universe. In particular, they will use data from current and future European Space Agency missions measuring cosmic microwave background radiation and gravitational waves. "Our aim is to measure the interaction between gravity and the Higgs field using cosmological data," says Professor Rajantie. "If we are able to do that, we will have supplied the last unknown number in the Standard Model of particle physics and be closer to answering fundamental questions about how we are all here."

***Reference**: M. Herranen, T. Markkanen, S. Nurmi, A. Rajantie. **Spacetime Curvature and the Higgs Stability During Inflation**. Physical Review Letters, 2014; 113 (21) DOI:10.1103/ PhysRevLett.113.211102)*

- **Scientists propose existence and interaction of parallel worlds: Many Interacting Worlds theory challenges foundations of quantum science**

Academics are challenging the foundations of quantum science with a radical new theory on parallel universes. Scientists now propose that parallel universes really exist, and that they interact. They show that such an interaction could explain everything that is bizarre about quantum mechanics. In a paper published in the journal *Physical Review X*, Professor Howard Wiseman and Dr Michael Hall from Griffith's Centre for Quantum Dynamics, and Dr Dirk-Andre Deckert from the University of California, take interacting parallel worlds out of the realm of science fiction and into that of hard science.

The team proposes that parallel universes really exist, and that they interact. That is, rather than evolving independently, nearby worlds influence one another by a subtle force of repulsion. They show that such an interaction could explain everything that is bizarre about quantum mechanics.

Quantum theory is needed to explain how the universe works at the microscopic scale, and is

believed to apply to all matter. But it is notoriously difficult to fathom, exhibiting weird phenomena which seem to violate the laws of cause and effect. As the eminent American theoretical physicist Richard Feynman once noted: "I think I can safely say that nobody understands quantum mechanics." However, the "Many-Interacting Worlds" approach developed at Griffith University provides a new and daring perspective on this baffling field. "The idea of parallel universes in quantum mechanics has been around since 1957," says Professor Wiseman. "In the well-known "Many-Worlds Interpretation," each universe branches into a bunch of new universes every time a quantum measurement is made. All possibilities are therefore realised -- in some universes the dinosaur-killing asteroid missed Earth. In others, Australia was colonised by the Portuguese."But critics question the reality of these other universes, since they do not influence our universe at all. On this score, our "Many Interacting Worlds" approach is completely different, as its name implies."

Professor Wiseman and his colleagues propose that: (i) The universe we experience is just one of a gigantic number of worlds. Some are almost identical to ours while most are very different; (ii) All of these worlds are equally real, exist continuously through time, and possess precisely defined properties; (iii) All quantum phenomena arise from a universal force of repulsion between 'nearby' (i.e. similar) worlds which tends to make them more dissimilar.

Dr Hall says the "Many-Interacting Worlds" theory may even create the extraordinary possibility of testing for the existence of other worlds."The beauty of our approach is that if there is just one world our theory reduces to Newtonian mechanics, while if there is a gigantic number of worlds it reproduces quantum mechanics," he says."In between it predicts something new that is neither Newton's theory nor quantum theory."We also believe that, in providing a new mental picture of quantum effects, it will be useful in planning experiments to test and exploit quantum phenomena."

The ability to approximate quantum evolution using a finite number of worlds could have significant ramifications in molecular dynamics, which is important for understanding chemical reactions and the action of drugs. Professor Bill Poirier, Distinguished Professor of Chemistry at Texas Tech University, has observed: "These are great ideas, not only conceptually, but also with regard to the new numerical breakthroughs they are almost certain to engender."

Reference: *Michael J. W. Hall, Dirk-André Deckert, Howard M. Wiseman.* ***Quantum Phenomena Modeled by Interactions between Many Classical Worlds****.Physical Review X, 2014; 4 (4) DOI: 10.1103/PhysRevX.4.041013.*

Editor`s Note: These details are fascinating to read. At times the reader is awe struck imagining about dynamics of Universe. It is essential for every earth system scientist, to spare some time and read such articles (even though they have nothing in common with their specialization) to reinvigorate thought process instead of stuck up in a hole.

Living Legends--Know Your Peers

Prof. U. R. Rao

Considered one of the leading space scientists in the world, **Dr Udupi Ramachandra Rao** was born on March 10, 1932, in Admar village, south Canara, Karnataka state. In 1953, he obtained M.Sc from Varanasi (Benaras) Hindu University. The same year he went to Ahmadabad and joined the Physical Research Laboratory (PRL) to pursue research on cosmic rays under the guidance of Dr. Vikram Sarabhai. In 1960, he received PhD. In 1961, he received post-doctoral fellowship from the Massachusetts institute of Technology, Boston. There he carried our further research on cosmic rays and solar winds. After two years of research, he worked as assistant professor at South West Center for advance Studies in Texas University, from 1963 to 1966. In 1966, he returned to India and once again joined PRL as Fellow and carried out research on X-rays and gamma rays in cosmic rays. These research studies / experiments involved use of balloons, rockets and satellites, which were used as payloads. In 1970, he became professor. During his stay at PRL, he and his colleagues made important contributions towards understanding the interplanetary medium. His research on solar winds has increased our understanding of the subject. The data interpretation of American Satellites pioneer I and Pioneer II became easy due to his researches. His understanding of the solar winds by unravelling the American satellite Mariner II observations provided a new insight to the world of science. He was the first to establish the relationship between geomagnetic storms and solar winds with the help of observations made on earth. For his highly accurate analysis of the Pioneer 6, 7, 8, and 9 observations, he was awarded the 'Group achievement Award, by National Aeronautics & Space administration (NASA) in 1973. In 1972, he was appointed as Director of ISRO Satellite Centre in Bangalore.

At Banglore, he started development of the new institute and after Dr. Sarabhai's death, fully concentrated on enriching the space department and reinforcing the satellite technology. This resulted in the design and construction of India's Aryabhatt satellite in 1975, under his guidance. This was successfully launched from the Russian Cosmodrome and was well in control thereafter. Then the design, development and successful orbit of Bhaskar I and II were carried out in 1979 and 1981. Under Rao's leadership, the first experimental geostationary satellite 'Apple' was put into orbit in June, 1981. This gave a boost to the development of this new technology in the country. Thereafter, the Indian Remote Sending (IRS) satellites and the INSAT satellites for broadcasting and meteorological purposes were designed, developed and successfully sent into orbit. The success achieved in putting them in appropriate orbit has increased the faith in Indian scientists and technicians. All this happened under Prof. Rao's able leadership. On October 2, 1984 Prof Rao was appointed chairman of ISRO and secretary of Space Commission, Government of India. He was entrusted the entire responsibility of the country's space programme. Taking forward the programme by guiding the scientists and engineers, he performed his duties successfully till 1994. Under his leadership the country's space programs took a giant leap and made various achievements. During his tenure, satellite launch vehicles were produced. This achievement was recognized. Launch vehicles like the ASLV, which could launch a satellite with a payload of 150 Kg in lower orbit and PSLV, which could launch a satellite with a payload of 1000 kg in polar orbit were prepared. Besides, special cryogenic engines are acquired to produce launch vehicles for GSLV geostationary satellites. These satellite launch vehicles can put satellites with 2.5 ton payload into orbit. Prof Rao has played an important role in enhancing India's name in the world of space science. In 1975, the Russian Science Academy, while praising his efforts for the successful launch of Aryabhatt satellite, honoured him with the Russian 'Medal of Honour'. The same year, he was awarded the 'Dr. Vikram Sarabhai Research Award' instituted by the Hariom Ashrama, for his contribution to space physics. He was also awarded the 'Dr. Shantiswaroop Bhatnagar Prize' for his

contribution to engineering science. The Karnataka government conferred on him the 'State Award'. In 1980, the Indian Engineering Institute gave him the 'National Design Award' and for his contribution to electronics science and technology, he was given the year's 'Vasvik Research Award'. For his services to the country, the President conferred on him the Padma Bhushan.

In 1987, the National Science Academy awarded Rao the 'P C Mahalanobis Medal'. In 1991, the Russian Space Flight Federation honoured him with the 'Yuri Gagarin Medal'. In 1992, for his cooperation in the journey of space, the international community (of which he is the Vice-president) awarded him the 'Allen D'mil Memorial Award'. In 1995, India's scientific community honoured him with the 'Aryabhatt Award'. The same year he was given the Bhasin Award. Kolkata (Calcutta) University along with Mysore University, as well as other universities in the country and abroad have conferred on him honorary doctorate degrees. The National Science Academy, Institute of Electronics and Telecommunications, National Engineering Academy, and Indian Astronautical Society have honoured him with Fellowships and gave him honorary membership. He is the president of the Indian Rocket Society. He was honoured as visiting scientist to Texas University. In 1996, he was presented the 'Dr. Vikram Sarabhai International Award'.

He has to his credit, more than 150 research papers. He has also written a book on the Aryabhatt project with his colleague Dr. Kasturirangan. It describes in detail about the project, its results and also analysis of its images. In 1996, he had detailed discussions with the then Prime Minister Narasimha Rao, on how science and technology would be useful in increasing foodgrain production, economic development and health of the country, and wrote a book in this connection. In nutshell his contributions resulted in establishing a firm platform that helped in significant success of space programs of the country. Young researchers of different branches of earth system can gain immensely, following his foot steps.IGU is indebted to him for helping it to stabilize, during his tenure (1985-87) as President of the Union.

Prof. D. Guptasarma

Dharmajit Guptasarma was born on 16 July, 1932, in Serajgunj, Dt. Pabna (now in Bangladesh). He obtained BSc with Physics Honours in 1950, and MSc in Radiophysics & Electronics in 1952, from Calcutta University, securing first rank in the university in both. He was awarded a Scientific Manpower Committee research fellowship of the Govt. of India, and worked as a research scholar for about 2 years under Prof Arun K. Chaudhury at the Inst. of Radiophysics & Electronics (RPE), and was then appointed a lecturer at the RPE without completing a PhD. He worked in the Geological Survey of India (GSI), Calcutta, from 1956 to 1965, and then joined the National Geophysical Research Institute (NGRI), Hyderabad, under the Council of Scientific and Industrial Research (CSIR), from where he retired as Director in July 1992.

Academic and research contribution

Professor Guptasarma pioneered the development of geophysical exploration instruments in India at GSI, and then at NGRI. He designed many instruments for land, airborne and ship-borne operations that were extensively used. With his team he discovered a diamond-rich kimberlite in Wajrakarur, Andhra Pradesh. He carried out theoretical and physical scale modeling to interpret geophysical measurements; invented faster, more accurate digital numerical filter operators; showed that low frequency electrical resistivity modeling in electrolytic tanks goes wrong due to surface polarization; that a published 'theorem' using the concept of contribution to the electric potential at a point by the electric fields around was wrong; that the transient response of a coincident-loop EM system cannot change its sign except in the presence of electrochemical polarizability. He discovered a novel method for computation of the magnetic field due to an arbitrary polyhedral object; this was then applied for computation of the gravity field due to any polyhedral object. He discovered a relationship between the frequency spectra of true and apparent polarizability of a buried target. He authored 43 research articles.

Other Contributions

He showed the need, and importance, of Very Long Baseline Interferometry (VLBI) measurements of the relative motion of the Indian tectonic Plate with respect to the Eurasian tectonic Plate for the proper understanding of the nature of the ongoing continent-continent convergence. He computed the sensitivity of missile launch systems to the gravity field of the earth structures. He showed that the seismic risk is not the same everywhere along the Himalayan collision belt.

Awards

Elected to fellowship of INSA (1987); Council Member (1991-93). Elected fellow of IASc, Bangalore (1987). Among the various other fellowships, awards and honours he received are: Father La Font Gold Medal (1950), Ganga Prasad Gold Medal (1952), Tripundeshwar Mitra Gold Medal (1952), Calcutta University Gold medal for MSc (1952), Krishnan Gold Medal (1972), UGC National Lecturer (1985-86), Decennial Award of IGU (1986), National Mineral Award (1986-87), Adjunct Professor in IIT, Kharagpur (1989). President Indian Geophysical Union (1991-93)

Shri. D. N. Avasthi

Shri. Devendranath Avasthi, President , SPS Consultants, New Delhi is a multifaceted personality, with vast experience in Oil Industry. He was born in 1933 in Karanpur**,** Fatehpur dist, U.P**.** He had early education in Asansol of W.Bengal and Fatehpur of U.P. He obtained M.Sc degree in Physics from Allahabad University, in 1955.He obtained Certificate in Geophysics from French Petroleum Institute, Rueil Malmaison, France (1958); Certificate in Computer Science, I.I.T. Kanpur (1964).He completed Computer Executive Course, I.B.M., New Orleans, U.S.A. (1969). Selected by UPSC for class I post of Geophysicist in ONGC in 1956 he served ONGC as Party Chief to Head of Geophysical Research and Computer applications, to Director (Geophysics) to Project Manager, General Manager, Group General Manager and Regional Director to Member (Personnel & Planning) at the Board level.. Over 50 years, he developed skills in project & general management to corporate planning and, research. Retired from Oil & Natural Gas Commission as a Member in the Board. Adviser to the Department of Science & Technology on Earth Systems Science, Member: Research Council of National Geophysical Research Institute of CSIR,Government of India and of ONGC Energy Centre, As President of SPS Consultants (for ~ 23 years) providing consultancy in projects related to petroleum exploration, unconventional and renewable energy resources. Member, Monitoring Committee of ONGC Research projects, Adviser: World Renewable Energy Technology Congress, World PetroCoal Congress and Geo Resources Technologies Consultancy (GRTC), Governing Body Member of Solar Energy Tribe. Developed and successfully initiated seismic survey techniques in hills, mountains and areas of uneven topography, including multi-shot coverage of seismic profiles as early as in 1958; Discovery of oil and gas in Cauvery and Krishna – Godavari basins and in West Sobhasan in Cambay Basin, Preparation of the First Development & Implementation Scheme for production from Bombay High discovery, Rejuvenating Hydrocarbons India Ltd (now ONGC Videsh Ltd., a subsidiary of ONGC and taking up exploration and related projects abroad; Advised the Government of India in the formulation & promotion of Oil exploration in India by international oil companies and in the re-organisation of Oil India Ltd. (OIL),; Advised ONGC in its various projects on Renewable Energy initiative. He was Vice President of ONGC Executives Association, for over 6 years.

He was awarded - Krishnan Gold Medal of the Indian Geophysical Union; Honour Award of the Association of Exploration Geophysicists; Golden Jubilee Honour Award in Geophysics of the Geological Survey of India; Decennial Award of the Indian Geophysical Union, Dr. Hari Narain Award of the Geological Society of India. B.S. Negi Convention Gold Medal and Life Time Honour Award of Society of Petroleum Geophysicists. He is also proficient in Hindi, English, Urdu, Bangla, French, Middle (ca.1400-1600) and working proficiency in Sanskrit, Persian, Punjabi and Gujarati.

P.R.Reddy