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SECTION OF

EARTH SYSTEM SCIENCES

President
Prof. Pramod K. Verma



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SECTION OF
EARTH SYSTEM SCIENCES

President : Prof. Pramod K. Verma

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I

PRESIDENTIAL ADDRESS

President : Prof. Pramod K. Verma

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Innovative Earth Science: Search for Water in Space

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Prologue

क्षिति जल पावक गगन समीरा, पंच तत्व यह रचा शरीरा ।

Since long we have known that water is one of the significant components making our life. In Indian literature, water has been regarded as one of three valuable things in life.

पृथिव्यां त्रीणि रत्नानि जलमन्नं सुभाषितम् ।

मूढैः पाषाणखण्डेषु रत्नसंज्ञा प्रदीयते ॥

It is understood that the "juvenile" water is one that has recently fallen from outer space, while "wise" water fell to earth, seeped into the ground, and mixed from various minerals before collection after hundreds of years. The "wise" water comes from deep beneath the earth, and thus the healing properties of water have been known for thousands of years. Our body is 90% water when we are born and 70% water when we mature. When water freezes over a lake, everything under the ice layer remains alive until the ice melts again. All this makes water unique and different from other liquids.

रहिमन पानी रखिए, बिन पानी सब सून ।
पानी गए न उबरे, मोती मानुष चून ॥

It is often said that the next world war will be over water. This statement itself indicates the future water scenario. It is true that two-third of our globe is occupied with water, yet there is dearth of drinking water. The whole world is making efforts to conserve, augment and manage drinking water resources. Despite all these sincere and dedicated efforts, ascertaining water security for the explosively growing population, however, remains challenge before the Earth Scientists.

Globally, the Earth Scientists are playing vital role in explaining the outer space, particularly its structure and composition. In India, the Earth Scientists have started contributing to this study very actively after the Chandrayaan data is available to interested researchers. Indian Space Research Organization has formulated a special group to look into the Chandrayaan data for understanding Lunar Geology. I am thankful to ISRO for including me in this group where, as novice, I am learning the nature of data obtained from space probes and trying to interpret in terms of Geology and allied characteristics.

The motivation behind this article is the significance of water not only for life but for evolution of Universe and, significance of water as energy provider for outer space missions (where sun light is not available). I must confess, the paragraphs to follow are just

compilation of knowledge and resources available in public domain. I sincerely acknowledge and salute the Earth Scientists who have made these available in public domain for interested learners like me. I wish this article would inspire and generate interest in Planetary Earth Science amongst young and innovative Earth Scientists of India.

Indicators of water in Space

A. Gamma Ray Spectrometer

The purpose of the gamma ray and neutron spectrometer (GRNS) is to provide information about the elements that make up surface crust. More exactly, it will provide information about the uppermost tens of centimeters of the crust. This instrument measures the numbers and energies of gamma rays and neutrons that reach the probe as it passes near the planet. Neutrons and gamma rays tell us what surface is made of by measuring the energy of each gamma ray and neutron that it detects.

The energy of a gamma ray is a kind of signature of the element from which it came. For example, oxygen nuclei can emit gamma rays of a certain energy (about 6 MeV), while iron atoms emit gamma rays of a completely different energy (about 7.6 MeV). Therefore, scientists can use data from this instrument to determine which elements are present on the surface.

Moreover, the number of gamma rays detected with a particular energy tells us how much of that element is present. For example, if there are a lot of gamma rays detected at about 7.6 MeV, one would expect to find a high concentration of iron on the surface of Mercury. So GRNS can help to tell us which elements are present and the relative concentrations of those elements. The numbers of fast and slow-moving neutrons detected by GRNS are clues to the relative abundance of light and heavier nuclei on the planet's surface.

B. Neutron Spectrometer

The Neutron Spectrometer measures neutrons and is the most important instrument on Lunar Prospector because it is the device that proves there is water on the Moon!

The Neutron Spectrometer consists of two almost identical instruments that divide the population of neutrons into high energy and low energy. They are both tiny canisters containing a special gas called helium-3 (or ^3He) which is made of two protons and one neutron. In the event when the ^3He is hit by a neutron it exchanges one of its protons for the neutron and is transformed into a new element (hydrogen-3 or ^3H , an isotope of hydrogen called "tritium") releasing a proton and large amount of energy that may be detected and counted.

The cosmic rays are present everywhere in space and constantly bombard the surface of the Moon. When cosmic rays strike an atom they release gamma rays and also dislodge neutrons that go flying out of the atom at a very fast speed ("hot" neutrons). Some of these dislodged neutrons will collide with materials in the Moon's surface and are slowed by the collisions (cooled). When a neutron collides an atom with a large nucleus the neutron will bounce off with only a slight loss in speed and its speed will be moderated only slightly. In a situation when the neutron hits a small nucleus it will be slowed down more because it will transfer more of its energy to its target. When a neutron hits a nucleus with the same mass as that of the neutron the incoming neutron will bounce off at only half its incoming speed. Protons and neutrons are almost identical in mass. When a neutron hits a proton (a hydrogen nucleus) it bounces off at half its original speed. If it hits another proton it loses half its speed again. The more protons (hydrogen atoms) in the neighborhood, the more the neutron collides with them, and the slower or "cooler" it gets. Hydrogen in the water is a perfect neutron moderator! The more water around them, the more the neutrons' speed is moderated ("thermal" neutrons). Neutrons bounced off any element other than hydrogen are moderated only slightly ("epithermal" neutrons). Presence of water hydrogen is indicated by an increase in the number of thermal neutrons and a decrease in the number of epithermal neutrons, because the hydrogen in water causes the neutrons to become more moderated.

Neutron Spectrometer is a very sensitive device and is able to detect water hidden slightly below the surface (about half a meter down). That's because the cosmic rays that produce the neutrons can penetrate pretty deep and the neutrons they produce can bounce around a lot before making their way to the surface.

Prospector's detector counted fewer medium energy neutrons at the poles because something there is slowing down the neutrons, moderating them. Water hydrogen is the most likely explanation for this moderation of neutrons. By carefully measuring the amount of "missing" epithermal neutrons, NASA estimated the amount of water on the Moon at 10 to 300 million cubic meters. Prospector has certainly shown there's a lot of water on the Moon and provided more useful data for our colonization of the Moon.

C. Infra-Red Spectrometer

Water is composed of one oxygen and two hydrogen atoms. It can be formed when hydrogen combines with a hydroxyl molecule (OH-). When a water or hydroxyl molecule absorbs energy, the component atoms oscillate, like ping pong balls glued to the ends of a Slinky. The outcome energy is near infrared light, specifically at 2.8 microns, roughly three to four times the wavelength of light our eyes can see. There is enormous amount of this wave length of light from the Sun, which would normally just bounce off the surface and be seen as reflected light by the spacecraft. But the water and

hydroxyl molecules absorb 2.8 micron light and the spacecraft *don't* see as much as expected. When we take a spectrum of the Moon, we see a big dip at that wavelength.

D. Presence of Clays

A new interpretation of years of mineral-mapping data, from more than 350 sites on Mars examined by European and NASA orbiters, suggests Martian environments with abundant liquid water on the surface existed only during short episodes. These episodes occurred toward the end of a period of hundreds of millions of years during which warm water interacted with subsurface rocks.

Discovery of clay minerals on Mars in 2005 indicated the planet once hosted warm, wet conditions. If those conditions existed on the surface for a long era, the planet would have needed a much thicker atmosphere than it has now to keep the water from evaporating or freezing. Researchers have sought evidence of processes that could cause a thick atmosphere to be lost over time. The types of clay minerals that formed in the shallow subsurface are all over Mars while the types that formed on the surface are found at very limited locations and are quite rare. This new study supports an alternative hypothesis that persistent warm water was confined to the subsurface and many erosional features were carved during brief periods when liquid water was stable at the surface.

The discovery of clay minerals by the OMEGA spectrometer on the European Space Agency's Mars Express orbiter added to earlier evidence of liquid Martian water. Clays form from the interaction of water with rock. Different types of clay minerals result from different types of wet conditions. During the past five years, researchers used OMEGA and NASA's Compact Reconnaissance Imaging Spectrometer, or CRISM, instrument on the Mars Reconnaissance Orbiter to identify clay minerals at thousands of locations on Mars. Clay minerals that form where the ratio of water interacting with rock is small generally retain the same chemical elements as those found in the original volcanic rocks later altered by the water.

The study interprets this to be the case for most terrains on Mars with iron and magnesium clays. In contrast, surface environments with higher ratios of water to rock can alter rocks further. Soluble elements are carried off by water, and different aluminum-rich clays form.

Another clue is detection of a mineral called prehnite. It forms at temperatures above about 200 degrees Celsius. These temperatures are typical of underground hydrothermal environments rather than surface waters. The interpretation is a shift from thinking that the

warm, wet environment is mostly at the surface to thinking it is mostly in the subsurface, with limited exceptions. On Earth, as reported, underground geothermal environments have active ecosystems."

Water in the Outer Space

A. Water at Quasar

A quasar is powered by an enormous black hole that steadily consumes a surrounding disk of gas and dust. As it eats, the quasar spews out huge amounts of energy. A quasar (called APM 08279+5255) located at more than 12 billion light-years away, is surrounded by a huge ocean, equivalent to 140 trillion times all the water in the world's ocean. The environment around this quasar is very unique in that it's producing this huge mass of water indicating that water is pervasive throughout the universe, even at the very earliest times.

Matt Bradford, a scientist at NASA's Jet Propulsion Laboratory in Pasadena, California and his team made their observations starting in 2008, using an instrument called "Z-Spec" at the California Institute of Technology's Submillimeter Observatory, a 10-meter telescope near the summit of Mauna Kea in Hawaii. The second group in 2010, led by Dariusz Lis, senior research associate in physics at Caltech and deputy director of the Caltech Submillimeter

Observatory, used the Plateau de Bure Interferometer in the French Alps to find water.

Water vapor is an important trace gas that reveals the nature of the quasar. In this particular quasar, the water vapor is distributed around the black hole in a gaseous region spanning hundreds of light-years in size (a light-year is about six trillion miles). Its presence indicates that the quasar is bathing the gas in X-rays and infrared radiation, and that the gas is unusually warm and dense by astronomical standards. Measurements of the water vapor and of other molecules, such as carbon monoxide, suggest there enough gas to feed the black hole until it grows to about six times its size. Whether this will happen is not clear, the astronomers say, since some of the gas may end up condensing into stars or might be ejected from the quasar.

B. Water around TW Hydrae

When light breaks up into individual colors, it provides information about the object emitting that light including its composition and temperature. Water emits light at a lot of specific colors in the IR, but there is one in particular that reveals its temperature.

Water is made up of one oxygen atom and two hydrogen atoms: H₂O. Each hydrogen atom has a proton in it, and protons have a property called '*spin*'. They can spin either one way or another;

called spin *up* or spin *down*. This is important because the total amount of energy in a water molecule is different if the two hydrogen atoms spin the same way (say, both up) versus different ways (one up and the other down). The first case is called *ortho*, and the second *para*. Each emits a slightly different wavelength of light, which can be measured. It is observed that, at room temperature water, the ortho water molecules are three times as the para molecules. However, as the temperature drops that ratio gets closer to 1. The strength of the line (amplitude in the spectrum) relates to the quantity of water. The observation at TW Hydrae indicates the ratio low enough to know that the water is cold, and must be coming from farther out in the disk than is usually seen. The amount estimated is enough to fill "thousands of Earth oceans".

C. Water at Planet GJ 436 b

A Neptune-size extra solar planet likely covered in hot—but solid—water has been discovered in a snug orbit around a nearby star. The planet, called GJ 436 b, orbits a cool, red star at a distance of only 4 million kilometres (By contrast, Mercury, the innermost planet in our solar system, is 47 million kilometers from the sun at its closest approach). The "hot ice world" is about 30 light-years from the sun. The exotic water detected on the planet is known to form under extremely high pressure—conditions that can only be replicated on Earth in laboratories.

Four Times Earth's Size, GJ 436 b was first detected in 2004 and was calculated at least 22 times as massive as Earth. Careful observations of the transit allowed calculating the size of the planet—about four times the diameter of Earth—and also pinned its mass as 22 times that of Earth. Knowing the size and mass of the planet allowed the team to infer it is mainly composed of water, based on models developed by Jonathan Fortney at NASA Ames Research Center in Moffett Field, California. If the planet contained mostly hydrogen and helium, like Jupiter, it would be much larger. And if it were made of rock and iron, it would be much smaller, like Earth and Mars, according to the model.

Since the planet orbits so close to its star, astronomers expect a minimum surface temperature of 475 degrees Fahrenheit (245 degrees Celsius). And, the astronomers said, pressures within the planet are intense, allowing for the exotic "hot ice." Since the planet is thought to be primarily a water world, the pressure acts on the water. Water has more than a dozen states, only one of which is familiar ice. Under very high pressure, water turns into other solid states denser than both ice and liquid water, just as carbon transforms into diamond under extreme pressures. Inside the planet, the exotic ice is heated to several hundred degrees. The planet is likely enveloped by hydrogen or helium, like Neptune or Uranus, but could be surrounded by water vapor. This planet should have a substantial component of its interior, maybe even most of it, being made of this solid form of water.

Water on Europa

Europa is the smallest of Jupiter's Galilean satellites. It has a diameter of 3,130 km, about the size of Earth's Moon, and is covered with white and brown colored water ice. With the exception of Earth, Europa currently appears to be the only body in the solar system which potentially harbors a global ocean of liquid water. This putative ocean is hidden under Europa's frozen surface crust. Close-up images returned by the Galileo spacecraft showed areas which have similarities to ice-floe covered arctic oceans on the Earth. Fractures and apparent movement of the icy surface plates, as in this Galileo image, suggest the existence of water or warm "slushy" ice below a frozen surface.

Observations of Europa show the geometric albedo is generally high, indicative of a reflective surface. Earth-based observations of the infrared spectra of Europa used Michelson interferometer spectrometers and showed that Europa strongly absorbs infrared light with wavelengths of 1.4 and 1.8 microns. This is a distinctive characteristic of water ice, and the strength of the absorption in these bands coupled with the otherwise high albedo is indicative of comparatively uncontaminated ice.

The surface of Europa is broken up into large plates and covered with extensive fractures. The plates in many regions appear to have shifted and rotated, and can be fit back together like pieces in a

puzzle. The wide fractures and relative movement and rotation of the surface plates indicate the crust is brittle but is underlain by a softer, more fluid, substance. Presumably this would be water or warm, slush-like ice. It is possible that the plate movements occurred in the past and the water layer is now frozen and can no longer move. However, the surface of Europa is not blanketed with impact craters, an indication that it may be relatively young and still mobile.

Most planetary scientists believe that a layer of liquid water exists beneath Europa's surface, kept warm by tidally generated heat. The heating by radioactive decay, which is almost the same as in Earth (per kg of rock), cannot provide necessary heating in Europa because the volume-to-surface ratio is much lower due to the moon's smaller size. Europa's surface temperature averages about 110 K ($-160\text{ }^{\circ}\text{C}$; $-260\text{ }^{\circ}\text{F}$) at the equator and only 50 K ($-220\text{ }^{\circ}\text{C}$; $-370\text{ }^{\circ}\text{F}$) at the poles, keeping Europa's icy crust as hard as granite. The first hints of a subsurface ocean came from theoretical considerations of tidal heating (a consequence of Europa's slightly eccentric orbit and orbital resonance with the other Galilean moons). Galileo imaging team members argue for the existence of a subsurface ocean from analysis of Voyager and Galileo images. The most dramatic example is "chaos terrain", a common feature on Europa's surface that some interpret as a region where the subsurface ocean has melted through the icy crust. This interpretation is extremely controversial. Most geologists who have studied Europa favor what

is commonly called the "thick ice" model, in which the ocean has rarely, if ever, directly interacted with the present surface. The different models for the estimation of the ice shell thickness give values between a few kilometers and tens of kilometers.

The best evidence for the thick-ice model is a study of Europa's large craters. The largest impact structures are surrounded by concentric rings and appear to be filled with relatively flat, fresh ice; based on this and on the calculated amount of heat generated by Europan tides, it is predicted that the outer crust of solid ice is approximately 10–30 km thick, including a ductile "warm ice" layer, which could mean that the liquid ocean underneath may be about 100 km deep. This leads to a volume of Europa's oceans of 3×10^{18} m³, slightly more than two times the volume of Earth's oceans.

The thin-ice model suggests that Europa's ice shell may be only a few kilometers thick. However, most planetary scientists conclude that this model considers only those topmost layers of Europa's crust which behave elastically when affected by Jupiter's tides. One example is flexure analysis, in which the moon's crust is modeled as a plane or sphere weighted and flexed by a heavy load. Models such as this suggest the outer elastic portion of the ice crust could be as thin as 200 metres. If the ice shell of Europa is really only a few kilometers thick, this "thin ice" model would mean that regular contact of the liquid interior with the surface could occur through open ridges, causing the formation of areas of chaotic terrain.

The Galileo orbiter found that Europa has a weak magnetic moment, which is induced by the varying part of the Jovian magnetic field. The field strength at the magnetic equator (about 120 nT) created by this magnetic moment is about one-sixth the strength of Ganymede's field and six times the value of Callisto's. The existence of the induced moment requires a layer of a highly electrically conductive material in the moon's interior. The most plausible candidate for this role is a large subsurface ocean of liquid saltwater. Spectrographic evidence suggests that the dark, reddish streaks and features on Europa's surface may be rich in salts such as magnesium sulfate, deposited by evaporating water that emerged from within. Sulfuric acid hydrate is another possible explanation for the contaminant observed spectroscopically. In either case, since these materials are colorless or white when pure, some other material must also be present to account for the reddish color, and sulfur compounds are suspected.

Water on Saturn

Water has been seen deep in Saturn's atmosphere before, but a few years back it was detected in the upper atmosphere as well. It was difficult to explain as how water gets it from deep down in Saturn to the top parts of its clouds. The tiny, icy moon Enceladus was discovered to have geysers at its south pole, actively spewing out quite a bit of water into space. Apparently, about 3-5% of the water from Enceladus's geysers falls on Saturn, literally raining down in

sufficient quantities to explain the presence of the water detected in the ringed planet's upper atmosphere.

Enceladus, Saturn's sixth-largest moon, has a frigid, icy surface but an active interior, particularly at its south pole. In this dynamic region, geothermal activity is concentrated at four trenches that are dubbed "tiger stripes," because of their distinctive surface markings. These fissures, which measure approximately 130 kilometers long and 2 km wide, form icy geysers that spew plumes of water vapor into space. Enceladus expels roughly 250 kilograms of water vapor every second through its tiger stripe jets. Observations from the European Space Agency's Herschel space observatory revealed that this water raining from Enceladus creates a doughnut-shaped ring of water vapor around Saturn.

The total width of the water vapor ring is more than 10 times the radius of Saturn, yet it is only about one Saturn radius thick. Despite the size of the ring, it had not been detected prior to now because water vapor is transparent to visible light, researchers said. Yet, Herschel's eyes, which are tuned to infrared wavelengths, were able to spot the curious feature.

Computer models based on the latest findings from Herschel estimate that between three to five percent of the water spewed by Enceladus ends up falling onto Saturn. While most of Enceladus' rain is either lost in space, freezes on Saturn's rings, or potentially

even falls onto the planet's other moons, what does reach the ringed planet is sufficient enough to explain the water in its upper atmosphere.

Water on Moon

Three different spacecraft — Cassini, Deep Impact, and Chandrayaan-1 — all see the signature of water on moon.

Chandrayaan-1, India's first-ever moon probe, was aimed at mapping the lunar surface and determining its mineral composition. The Moon Mineralogy Mapper (M3) detected wavelengths of light reflected off the surface that indicated the chemical bond between hydrogen and oxygen (the telltale sign of either water or hydroxyl). Because M3 can only penetrate the top few millimeters of lunar regolith, the newly observed water seems to be at or near the lunar surface. M3's observations also showed that the water signal got stronger toward the polar regions.

Cassini, which passed by the moon in 1999 on its way to Saturn, provides confirmation of this signal with its own slightly stronger detection of the water/hydroxyl signal. The Cassini data shows a global distribution of the water signal, though it also appears stronger near the poles.

The Deep Impact spacecraft, as part of its extended EPOXI mission and at the request of the M3 team, made infrared detections of water

and hydroxyl as part of a calibration exercise during several close approaches of the Earth-Moon system en route to its planned flyby of comet 103P/Hartley 2 in November 2010.

Deep Impact detected the signal at all latitudes above 10 degrees N, though once again, the poles showed the strongest signals. With its multiple passes, Deep Impact was able to observe the same regions at different times of the lunar day. At noon, when the sun's rays were strongest, the water feature was lowest, while in the morning, the feature was stronger. The Deep Impact observations of the Moon not only unequivocally confirm the presence of [water/hydroxyl] on the lunar surface, but also revealed that the entire lunar surface is hydrated during at least some portion of the lunar day.

The findings show that not only is the moon hydrated, the process that makes it so is a dynamic one that is driven by the daily changes in solar radiation hitting any given spot on the surface. There are potentially two types of water on the moon: that brought from outside sources, such as water-bearing comets striking the surface, or that that originates on the moon. This second, endogenic, source is thought to possibly come from the interaction of the solar wind with moon rocks and soils. The rocks and regolith that make up the lunar surface are about 45 percent oxygen. The solar wind, the constant stream of charged particles emitted by the sun, is mostly protons, or positively charged hydrogen atoms. If the charged hydrogen, which is traveling at one-third the speed of light, hit the lunar surface with enough force, it breaks apart oxygen bonds in soil

materials. Where free oxygen and hydrogen exist, there is a high chance that trace amounts of water will form. The various study researchers also suggest that the daily dehydration and rehydration of the trace water across the surface could lead to the migration of hydroxyl and hydrogen towards the poles where it can accumulate in the cold traps of the permanently shadowed regions.

The Moon has no atmosphere, any substance on the lunar surface is exposed directly to vacuum. For water ice, this means it will rapidly sublime directly into water vapor and escape into space, as the Moon's low gravity cannot hold gas for any appreciable time. Over the course of a lunar day (~29 Earth days), all regions of the Moon are exposed to sunlight, and the temperature on the Moon in direct sunlight reaches about 395 K. So any ice exposed to sunlight for even a short time would be lost. The only possible way for ice to exist on the Moon would be in a permanently shadowed area.

The Clementine imaging experiment showed that such permanently shadowed areas do exist in the bottom of deep craters near the Moon's south pole. Much of the area around the south pole is within a giant impact crater 2500 km in diameter and 12 km deep at its lowest point (South Pole-Aitken Basin). Many smaller craters exist on the floor of this basin. Since they are down in this basin, the floors of many of these craters are never exposed to sunlight. Within these craters the temperatures would never rise above about 100 K. Any water ice at the bottom of the crater could probably exist for billions of years at these temperatures.

Epilogue

Water is present in the space, at several places, from the cratered highlands to the smoother darker plains, in amounts up to a liter per cubic meter of material to an ocean that may consume tens of Earth's oceans. It may be a big surprise for people struggling for water security. However, it means that eventually, lunar colonies (and in remote future, colonies at moon like Europa etc.) may be able to extract water from its own surface and to extract oxygen from its own materials. Once Mahatma Gandhi told, "the nature has everything to feed one's need but has nothing to feed one's greed". We must not forget that the Universe is for all and must respect our forefather's saying:

अयं निजः परो वेति गणना लघुचेतसाम् ।
उदारचरितानां तु वसुधैव कुटुम्बकम् ॥

Further, search for water also relates to search for life in space. Looking for life, the astrobiologists look for Earth like environment in space. Even on earth we know that there are hundreds of species that dwell in highly saline environment in oceans. The researchers proposed two indexes to assess a body's probability of hosting life. The first measured conditions that could possibly support life; the other measured similarity to Earth, as it's the only planet known to support life. It is always suspected that the life may be in existence in space in the environment which may support different kind of life, for which our knowledge is yet to be enriched.

According to the Planet Habitability Index (PHI), the body most likely to harbour life in our solar system is Saturn's largest moon Titan, with a PHI of 0.64. The next highest is Mars at 0.59. Titan is the only moon in our solar system to boast a substantial atmosphere and the only body other than Earth known to have lakes (although Titan's lakes are most likely liquid methane.) According to the Earth Similarity Index (ESI), the planet with the most Earth-like conditions is Gliese 581g. First proposed in September 2010, it's believed to have an ESI of 0.89, compared to 1.0 for Earth.

It is said, "Sky is the limit". The search for water or life in space is an effort not to cross this limit but to know the limit. Nevertheless, Water and Life, to our present knowledge, go together and strengthen the saying: जल ही जीवन है ।

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II

**ABSTRACT OF
PLATINUM JUBILEE
LECTURE**

PLATINUM JUBILEE LECTURE

Earth System Science in India: A perspective

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The Earth behaves as a single inter-linked system. The energy and material transfer within and across different sub-systems, viz., atmosphere, ocean, cryosphere, geosphere, and biosphere are complex. The understanding of such interactions can lead to improved prediction of weather, climate and hazards for societal, economic and environmental benefits. The net economic benefit of services can be of order of 0.4 to 1.2 per cent of GDP.

Weather and Climate prediction over India is focused on the monsoons and has a history of well over a century. The short-term weather forecast has improved considerably and being used to generate advisories for farmers. As climate change issues take center stage, the need for a deeper understanding of the components of earth systems is recognized as critical for learning how the earth is changing. The long-term measurements, both in situ and satellite are crucial for improved predictive capability to forecast weather, climate and hazards. The atmospheric and ocean observations are being augmented by deploying automatic weather stations, automatic rain gauges, doppler weather radars, argo floats, HF radars, moored buoys, current meters, etc. Capacity building in climate change research is also paramount for responsible stewardship of the Earth as an integrated and it is an investment that will pay dividends for generations to come. A number of programs focused on monsoons to earthquakes to energy and ecosystems are being planned to tackle these important issues. The success of these programs depends not only on technology and infrastructure but on

people, an education system that produces the scientists and managers needed for implementing such an approach. We need to build effective communication with various stake-holders including policy makers.

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III

**ABSTRACT OF
YOUNG SCIENTIST AWARD
PROGRAMME**

YOUNG SCIENTIST AWARD LECTURE

Sustainable Development of Groundwater Resource through Spring Line Determination in Chhatna Block, Bankura District, West Bengal – A GIS approach

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For sustainable development of water resources, all planning should be based on the character of the hydrological environment of the area. In any area, it becomes often difficult to locate areas for construction of groundwater development structures due to lack of proper understanding of the recharging and discharging zones of groundwater of an area. So in this paper the main attempt has been made to demarcate the recharging and discharging zones of groundwater of the area and the spring line, which is a natural line and separates these two zones. The sites of groundwater development structures and sites of artificial recharge and water harvesting structures are then selected on the basis of the Recharge - discharge zone map of the area.

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IV

**ABSTRACT OF
K P RODE MEMORIAL
LECTURE**

K P RODE MEMORIAL LECTURE

The Enigmatic Vindhyan Rocks

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Because of its enormous thickness, pattern of distribution, unique stratigraphic position & absence of undisputed fossil remains the vindhyan formations of peninsular India remained puzzling. Throughout the last century attempts were made at regular intervals to establish the age.

The available evidences can be classified as –

- (1) Litho logic
- (2) Paleontological
- (3) Radioactive dating
- (4) Late Proterozoic glaciator
- (5) Sedimentological evidences.

The earliest paleontological evidence goes back to 1907 when H.C. Jones discovered round and oval carbonaceous discs from the sukhet shale near Rampara. Much Controversy has centered around this findings which has been referred as brachiopods (Chapman, 1935); algae (Sahni,1995) and as inorganic matter- (Misra & Dube, 1952) a case of colloidal precipitation.

Close similarities between stromatolites and those of the upper part of the lower Ripheans of Russia was observed by Vildiya.(900 m.a.).

Age of upper Kaimir was worked out to be 809+36 m.y by Vinogradov and Tugarinova. Later Crawford and compston took the

Vindhyan to 1200 to 1400 million years by Rb-Sr dating. Banerjee and Frank found by preliminary $^{40}\text{Ar}/^{39}\text{Ar}$.

The tectonoblastic of metazone(1100 Ma) in the Chhota Nagpur fm. Azmi(1998) through a couple of papers reported lower Cambrian small shaly fossils and brachiopods from the lower Vindhyan stratigraphy and Paleontology took place during March 1999. Criticism from the various workers about Azmi's work reached such a stage that the Geological Society of India had to announce that no further correspondence on this topic will be entertained.

Joe Meert et. al.(2008) on the basis of their study of the magnetic field of samples collected by drilling through sites at Son valley and Rajasthan revealed an age of about 1.02 billion years. This if firmly established would push down the age much below 500 million years.

99th Indian Science Congress
January 3-7, 2012, Bhubaneswar

V

**ABSTRACTS OF
LECTURES OF FOREIGN
SCIENTISTS**

ABSTRACTS OF LECTURES OF FOREIGN SCIENTISTS

1 Science and Technology Indicators in India: Policy Geography

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Keywords: Geography, Indicators, Policy, Science & Technology planning

In recent year's science and technology based economic development has been well recognized not only in the advanced capitalist countries but also in emerging economies such as India. Under the impact of globalization the notion of innovation has become pivotal in regional economic development. This research provides an overview of science and technology indicators (academic R&D, employment in high-technology industries, patents, number of ph.ds etc.) and outlines the problems involved in developing policies to promote regional economic development. The complex and specific nature of regional issues in mature regions (Bangalore, Delhi, and Hyderabad among others) is considered in the context of globalization and changes in science and technology indicators. In particular, the focus of this research is on the issues related to the interrelated themes of strategic science and technology planning, spatialized public policy and politics of scale and the challenges that these pose for policies designed to promote such mature regions.

2 Egypt in the Framework of Global Tectonics

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The crystalline basement of Egypt is mainly Precambrian in age and composed of igneous and metamorphic rocks exposed in the Eastern Desert, southwestern corner of the Western Desert, and in the southern part of Sinai Peninsula. Three ages for the basement rocks indicate a growth from a Middle Archean (2673 Ma) continental nucleus (referred to as the Nile Craton) to the modern continent by addition of Late Proterozoic to Eocambrian (1200-450 Ma) juvenile crust through the Pan-African orogen.

Phanerozoic rocks are dominated by relatively undeformed and unmetamorphosed sedimentary strata, with most tectonic activity concentrated and in fact responsible for the modern continental margins of NE Africa. Minor igneous activity occurred in the Phanerozoic with alkaline magmatism in the Paleozoic and Mesozoic and tholeiitic in the Cenozoic.

The Paleozoic of Egypt started with the final stages of the Pan-African arc accretion onto the Nile Craton. Sedimentation for most of the Paleozoic was controlled by global eustatic sea level changes, with clastic sediments derived from Pan-African high lands, which were probably glaciated for at least the first half of the Paleozoic as Egypt was drifting south reaching its most southerly Phanerozoic latitude with the location of Cairo at almost 70° S during the Ordovician. Since the Late Ordovician-Early Silurian, plate motions have been transporting Egypt north to its modern position with the location of Cairo at latitude of approximately 30° N. During Paleozoic, the Kufra basin in south Egypt and the Dakhla basin in east central Egypt were formed possibly due to relaxation of the thermal anomalies generated during the closing stage of the Pan African crustal accretion. Toward the end of Paleozoic, southern Egypt formed a structural high. The uplift was associated with E-W

faults, alkaline volcanism and ring complex derived from mantle source material emplaced along reactivated Pan African fractures. Carboniferous to Triassic magmatism was roughly coincident with the Hercinian (Variscan) orogeny in Europe and the creation of the single super continent of Pangaea (Lurasia and Gondwanaland). Lurasia was moving westward relative to Gondwanaland at that time resulting in some closure of the Tethys to the north of African-Arabian landmass.

During the Mesozoic, northern Africa was affected by three tectonic events; 1- uplift and major extensional tectonics and block faulting and tilting associated with the opening the Neotythes, 2- formation of the broad folding of the Syrian Arcs due to rifting of the south Atlantic and closure of the Neotythes and collision of Eurasia with the Afro-Arabian plate in the Late Cretaceous, and 3- rifting in NE Africa with an axis of extension perpendicular to the axis of folding.

During the Cenozoic, magmatic activity changed to tholeiitic basalt associated with Red Sea rifting at the Oligo-Miocene time. At the end of the Red Sea, the opening is split between the opening of the Gulf of Suez and sinistral shear along the Gulf of Aqaba-Dead Sea rift System. For the last 10 Ma, little extension appears to have occurred across the Gulf of Suez, but expansion has continued along the Gulf of Aqaba.

3 Relationships of Modified Mercalli Intensity with Return period and Pick Ground Acceleration for Hormozgan Province in Southern part of Iran

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KEYWORDS: Modified Mercalli Intensity, Peak Ground Acceleration, return period, Hormozgan Province.

Hormozgan Province (52° 30' - 59° E, 25° -29° N) is located in the Southern part of Iran. Historical earthquakes show this region has had more than 880 events with magnitude 3 to 7 in the period of 1930 – 2007. In this study a method is developed to produce civil engineer codes for the desired relationships between such ground motion parameters as Modified Mercalli Intensity (MMI) and their average return periods for Bandarabbas Zone, Hajiabad Zone and Minab Zone of Hormozgan province. In addition we have calculated a relationship between return period and MMI and also seven relationships were suggested between MMI and Peak Ground Acceleration (PGA) for Hormozgan province. There is a fairly remarkable agreement between the PGA vs. MMI found in this research and the correlation calculated by others for a few regions.

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VI

**ABSTRACTS OF
SYMPOSIUM / INVITED
LECTURES**

PROCEEDINGS
OF THE
NINETY NINTH SESSION OF THE
INDIAN SCIENCE CONGRESS
BHUBANESWAR, 2012

PART II : (Abstract of Symposium/Invited Lecture)

SECTION OF
EARTH SYSTEM SCIENCES

President : Prof. Pramod K. Verma

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President : Prof. Pramod K. Verma

SYMPOSIUM

1 Reservoir Triggered Seismicity at Koyna, India

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Artificial water reservoirs have triggered the occurrence of earthquakes at over 100 sites on Earth. Triggered earthquakes exceeding M 6 have occurred in China, Zambia, Greece and India. Changes in the sub-surface pore fluid pressure regime and mechanical properties of the near-field zone are proposed to be the causative factors.

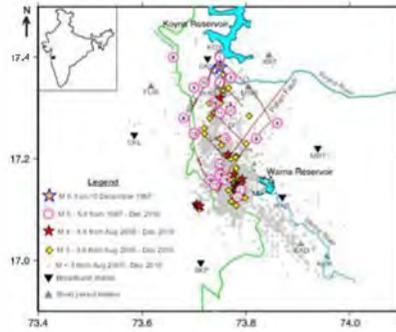


Figure 1: A map of Koyna-Warna region in Western India indicating the current and past seismicity along with the existing seismograph network and fault zones. Inset: Map of India indicating the study region.

A classical Reservoir Triggered Seismicity (RTS) site is Koyna, West Coast of India. Triggered earthquakes have been occurring in Koyna since the impoundment in 1962, including the largest RTS event of M 6.3 on December 10, 1967; 22 M > 5 earthquakes, and several thousand smaller ones (Figure 1). RTS increases following the monsoon rains and almost every year we have one or more M ~ 4 earthquakes. RTS was intense in 2009 and the latest M 5.1 earthquake occurred on December 12, 2009. The shallow (mostly < 6 km) RTS is confined to a small area of 20 x 30 sq. km with no other seismic activity within 50 km of the Koyna Dam. The Koyna region was stressed close to critical before the impoundment of the Koyna Dam and the maximum credible earthquake for the region is M 6.8. It is estimated that more than one half of this energy has been released since impoundment and RTS will continue for many more years. The occurrence of M > 5 is governed by factors like rate of loading, highest water level reached, duration of retention of high water levels, and whether the previous water level maxima has been exceeded or not (Kaiser Effect). Nucleation precedes M ~ 4 earthquakes, and its real time monitoring has led to short term forecasts.

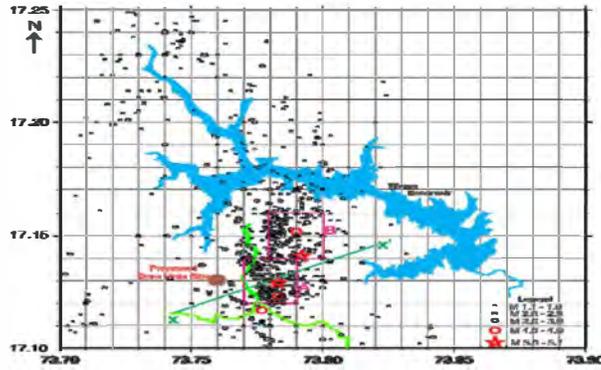


Figure 2: Seismic activity near the Warna reservoir during 2009 and 2010. A and B are the two areas, where intense clustering is visible. XX' is the P-wave velocity section shown in Figure 3.

Currently, a drilling project in the area is in a first conceptual planning phase. Tentatively, it is planned to be placed close to the Warna reservoir where the seismic activity has been most intense during the past two years (Figure 2). A 3D velocity model has been developed based on the operation of 97 seismic stations in the vicinity of the Koyna and the Warna reservoirs. This site of the proposed bore hole is located close to the location of the recent intense seismic activity (Figure 3). Depth sections for blocks A and B are shown in Figure 4. A deep borehole would provide direct observational data on the composition, physical state and mechanical behavior of a major active fault zone at focal depths of RTS. It would also be possible to test and constrain RTS hypotheses, faulting and earthquake generation in an intra-plate seismic zone, and contribute to earthquake hazard reduction. Down-hole measurements complemented by observations on cores and cuttings, analyses of fluid and gas samples, geophysical and geological site characterization studies including fault zone monitoring would help answer questions related to the genesis of RTS.

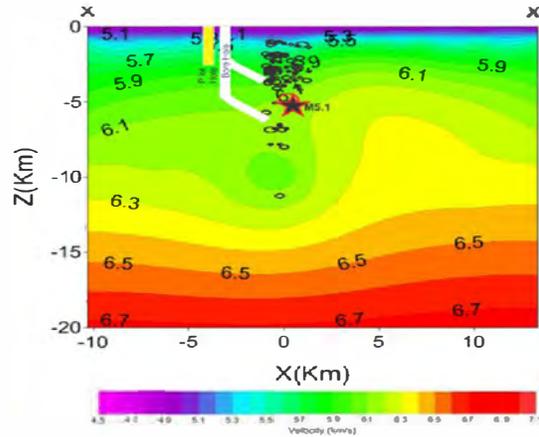


Figure 3: XX' is the vertical section from the 3D P-wave velocity model from DD tomography. Earthquakes that occurred during 2009 and 2010 near the proposed borehole site are also plotted.

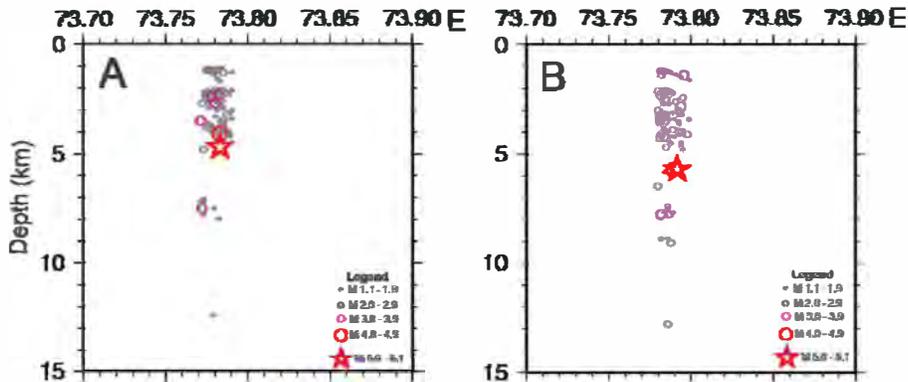


Figure 4: Depth sections across the fault in Blocks A and B shown in Figure 2. Number of earthquakes during 2009 and 2010 in Block-A: M 1.1–1.9 of 81 events; M 2-2.9 of 26 events; M 3-3.9 of 5 events and one earthquake each of M 4.3 and M 5.0. Block-B: M 1.1–1.9 of 54 events; M 2-2.9 of 24 events; M 3-3.9 of 7 events and one earthquake each of M 4.2 and M 5.1.

2 Tsunami: Its Origin, Earthquake Link and Prediction

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The essential prerequisite for triggering a Tsunami is the sudden displacement of sea/ocean water on a massive scale. Tsunami is generated as the disturbed water level attempts to attain equilibrium. All the Tsunamis in the Circum-Pacific belt are invariably accompanied with earthquakes. So intimate is the association that these ‘harbour waves’ are conventionally described as ‘Tsunamigenic’ or ‘earthquake generated Tsunami’ or ‘seismic sea waves’, The usage appears misleading because scientifically speaking both earthquake and Tsunami are manifestations of sudden dislodgement of rock masses during faulting. The energy released during disruption (or faulting) of strained rocks radiates from the source of origin as elastic waves. Some elastic wave cannot pass through a liquid medium, while some other gets considerably subdued.

We cannot prevent generation of a Tsunami, nor is it possible to make a precise prediction about it. There are, however, some warning signs of an impending tsunami. One of the early warnings of an incoming Tsunami is sounded by the nearby animals, which have the ability to sense danger and flee to higher ground before the water arrives. In regions of high risk a warning system, known as ‘Deep-Ocean Assessment and Reporting of Tsunamis (DART)’ is being used to detect approaching Tsunami.

The most viable approach for the poor maritime countries like ours would be to improve the living conditions of the coastal people who live in dangerously low-lying areas for their sheer

livelihood, and take other measures for mitigating dreadful effects of any such calamities.

3 Space Technology in studying the Impact of Climate Change

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Human activities contribute to climate change by causing changes in Earth's atmosphere in the amounts of greenhouse gases, aerosols (small particles), and cloudiness. Since the start of the industrial era (about 1750), the overall effect of human activities on climate has been a warming influence. The fourth assessment report of International Panel for Climate Change mentions the surface air warming: 1.8⁰C to 4.0⁰C (under different scenarios), Sea Level Rise of 0.18 – 0.59 m and high frequency in heat waves and heavy precipitation events. Climate change forms one of the most important global environmental challenges, with implications on food and water security, health, energy, etc. It is essential to study the impacts of climate change and thereby suggest mitigation measures. Goal of space based global change observation, together with other observations and studies, is to provide a sound scientific basis for developing national and international policy relating to natural and human induced changes in the Earth system. The observational need encompasses broad categories such as atmospheric compositions; ocean surface topography and physicochemical status; precipitation; and land surface imaging.

Satellite based remote sensing data helps in mapping earth resources, monitoring their changes and deriving bio-geophysical parameters. All this information helps in identifying the indicators

and agents of climate change. The space-based inputs can also be integrated with physical simulation models to predict the impact of climate change. It provides information related to three aspects i) the indicators of climate change ii) assessment of agents of climate change, such as greenhouse gases and aerosol, their sources and distribution pattern and iii) modeling the impact of climate change in various fields of natural resources that would be of help in planning towards adaptation measures and preparedness. A number of studies have been carried out at ISRO towards mapping/detecting the indicators of climate change, monitoring the agents of climate change and understanding the impact of climate change, in national perspectives. Towards mapping and monitoring of climate change indicators, the studies include glacier retreat, changes in polar ice cover, timberline change and coral bleaching.

Glaciers on 1:50,000 scale has been mapped for the entire Himalaya using IRS-LISS III/AWiFS data of 2004-07 time frame. The inventory shows that the total number of Gaciers in Indian Himalayas are 32392 and the total glaciated area is 71182 km². To study the impact of climate change, 2190 glaciers, distributed in all the climatic zones of Himalaya have been monitored for a period of 15 years. Study indicates that 76% of the glaciers have retreated whereas 7% have advanced and 17% have shown no change.

Studies have been carried out to monitor the shifting of timberline in Himalayan region.

Coastal zones are most vulnerable to the sea level rise (SLR) and the impact of climate change. Entire Indian coastal zone has been mapped using the high resolution LISS IV data of 2004-07 time frame. Models have been developed to study the impact of sea level rise on the coastal habitat/environment. The phenomenon of coral bleaching as a consequence of rise in sea surface temperature

has also been studied. The coral reefs have been mapped at eco-morphological levels for the entire Indian coast using IRS data. Desertification is another important indicator of climate change. Desertification status mapping has been done for the entire country on 1:50,000 scale using IRS-AWiFS data. This will serve as a base for future monitoring.

4 Emerging Geo-Frontiers for Human Welfare and Prosperity – Dimensions and Innovations

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The planet earth is a composite set of complex, interlocking and interacting systems undergoing rapid landscape transformation due to endogenic and even at much accelerated anthropogenic onslaughts and both further sculptured by exogenic process(es) are visibly shifting emphasis from *value* based to *volume* based, adversely affecting *the cyclic renewable agricultural* productivity and wasting assets dumping problem destabilizing balanced environment. Development interferes with geo-climatic inputs that often transform natural processes into natural hazards warning possible disaster ahead. Perhaps computation of *Ecoelsatic modulus* may help determining the sustainable limit. On the other hand, Aesthetic factor may indicate the scenic beauty.

- Mineral based industries practically exhausted high grade raw materials, now need opting for mineral dressing to cope with available technology; it may modify the landscape and pollute atmosphere and water.
- Agriculture Geology provides holistic natural attributes like climate, soil types, clay minerology, mineral fertilizers and hydrology a better input on land capability for proper landuse.

- Medical Geology - Human Health is key to prosperity. Studies on human calculi (urinary and biliary) mimicking natural sedimentary structures and nature of pulmonary diseases would help required medical aid. Pharmaceutical use of minerals as disintegrant and as binding agents and for denitrification formulation with lower abrasive and higher cleansing property, may also save foreign exchange.
- Forensic Geology introduced in 1973 by Ray Murray would help determining criminal habitat on his/her garments or footwear examination.
- Exploring *alternate energy* resource-locating suitable sites for geothermal, solar, wind and water energies and gas hydrate deposition; also in agricultural systems supporting growth of non-fertile hybrid *Miscanthus sinensis Giganteus* or sugarcane for gasoline production

Integration of such emerging aspects necessarily propels *de novo* look at geoscience education:

- ✚ to overhaul and restructure courses of studies
- ✚ limit in-depth pure / specialized and applied courses to post graduation and
- ✚ attach outdoor studies with field parties of government, public and private sectors mandatory which also
 - ❖ help organizational field operations
 - ❖ upgrade apprentice quality
 - ❖ build in employers perception about the prospective employee
- ✚ establish inducing self confidence and reliance four to five well equipped national centres of international standards spanning widest geographical and academic coverage
- ✚ promoting Academic Updating Programme from time to time
- ✚ organize specialists workshops for preparing *ideal* co-operative multiauthored text books with relevant illustrations from Indian studies

- ✚ delineate showcasing of operating geological processes and products in suitably located geological gardens like natural museum to excite insights into earth-related happenings.

5. A recipe for people's prosperity

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I would like to begin by quoting Dr. Koichiro Matsuura, “We are at the cross-roads in human history. Never before in the eight million year history of human kind has our planet been subjected to such rapid and profound changes... Our knowledge of Earth system is our insurance policy for the future of our planet.” Earth Science(s) as a major tool of innovation has constantly been part of human civilization since the beginning of the long journey of mankind on this planet Earth. Role of Earth Science is evident from the fact that periods of civilization have been named as stone-age, copper-age, etc. The first direct interaction of mankind with this subject dates back to Paleolithic times when he observed the usefulness of conchoidal fractures of flint pebbles to turn them into tools for digging and cutting. ‘Fire’, a major innovation, again owns its origin to quartz pebbles that were rubbed together. During the past two centuries of industrial revolution the human development and prosperity could be directly linked to consumption of Earth and energy resources. However, in the recent years the Earth Sciences seem to have fallen behind as the other disciplines of science and technology have grown at a much rapid pace. This resulted in dwindling interest in the subject and closure or reorganization of many Earth Science departments in the universities all over the world.

The scenario has changed again with the realization that Earth Science and people's prosperity are inseparable. To cope with the requirements of increasing population the significance of Earth Science cannot be over emphasized, not only in terms of finding new and alternative resources but also to apply growing understanding about the dynamic Earth for facing natural disasters.

The year 2007 was declared by UNESCO as the International Year of Planet Earth with an objective to disseminate the knowledge about the Earth to a large section of the world through combined participation of NGOs, governmental and academic institutions in order to make it a safer, healthier and wealthier place for future generations. There is need to strive further on the same path of innovation especially in the fields of water resource and management, disaster mitigation and management, development of geo-tourism. The other serious issue is the need to find alternative sources of energy as the conventional fossil fuel resources are drying up and the energy needs are growing.

6. Lunar Surface Composition using Chandrayaan-1 Hyperspectral Instruments

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Over the last three decades, India has achieved a successful space program, and made good progress in design, development and operation of space systems as well as applications for telecommunications, broadcasting, meteorology, natural resource mapping and management. With the successful launch of Chandrayaan-1 on October 22, 2008 we are now in a better position to pursue lunar and interplanetary sciences and applications of remote sensing data to understand evolution of our solar system and assessment of planetary resources. Chandrayaan-1 mission has

carried eleven world class instruments to conduct investigation relating to mineral distribution, lunar surface morphology and sub-surface structures, elemental distribution and to characterize radiation environment around the Moon. One of the three hyperspectral cameras flown on Chandrayaan-1 mission is Hyperspectral Imager (HySI), which is developed as Space Applications Centre, Ahmedabad to map the lunar surface for mineralogical and morphological investigations at high spatial and spectral resolution. The HySI camera measures reflected solar radiation from lunar surface in 64 spectral bands with a moderate spatial resolution of 80 meters. Chandrayaan-1 also carried another imaging hyperspectral instrument from JPL/NASA called Moon Mineralogy Mapper (M3) having a spectral range of 0.4 to 3.0 μm with a spatial resolution of 160 m in global mode.

Lunar surface is mainly composed of two major rock types, i.e., Lunar highland rocks and Lunar mare basalts. Lunar highland rocks are composed essentially of anorthosite which are calcium and aluminum rich rocks. The Lunar Maria are large, dark basaltic plains on moon. They are less reflective than the “high lands” as a result of their iron- rich compositions, and therefore appear dark to the naked eye. The Maria covers about 16% of the lunar surface, mostly on the nearside, visible from the Earth. The far side of the Moon is dominated by heavily cratered, light-colored highlands with only a few small, isolated dark maria patches. While near side surface morphological units have been studied extensively from earth based and space-borne spectral measurements, Chandrayaan-1 HYSI and M3 data have provided opportunity to examine the compositional properties of both the sides of Lunar Surface. Many studies have been carried out for mineral discrimination using HySI and M3 data. The data analysis of HySI along with TMC derived digital elevation model (DEM) for the Parts of Mare Orientale basin on the south

west of lunar surface has helped in providing the relationships between mineralogy and morphology of lunar landforms in this region. HySI derived hyperspectral data cube, reflectance spectra generated for different rock types has been used to detect primordial Lunar crust of anorthosite origin confirming the lunar evolution through the process of explained in lunar magma hypothesis. Quantitative estimates of Iron and Titanium on the Lunar surface could also be made using the empirical relationship between spectral reflectance ratios and sample return data from Apollo missions.

7. Recent Innovations in Earth Sciences: Role of Women Geoscientists in Channelizing Emerging Benefits

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Keywords: Earth Sciences, Geosphere, Planetology, Geoethics, Medical Geology, Climate Change, Green Earth, Geotechnology Innovations, Cosmos.

More comprehensive and inclusive term “Earth Sciences” has greatly evolved through the passage of time following the basics of evolutionary trends from Geology, Geophysics and Geochemistry to create the domain of Geosciences, which denote the integrated discipline of geological sciences, Subsumption of geosciences with meteorology, oceanography, astronomy and planetology led to the creation of a broader field of Earth Sciences or Earth Science, which gradually began to embrace the study of Geosphere as a whole, forming nexus of Earth System Sciences (ESS); it subsequently expanded into a vast expanse of knowledge with nearly 20 sub-disciplines, that now touch every stage of human life. Being still in the evolutionary process, the ESS has turned to be highly utilitarian with myriads of innovations that have been made in such a

framework, conveniently divisible into: First, development of earth sciences; Second, industrial development; and Third, societal benefits – modern researches intimately interacting with the corporate and societal sectors. Innovatory development and diversification gradually have advanced into non-traditional branches of geosciences, more important ones being Geo-hydrology, Geo-engineering, Global Tectonics, Geo-thermics, Petroleum Geology, Marine Geology, Urban Geology, Planetary Geology, Medical Geology: Geoethics and Geoconservation being deeply involved in them. Citing appropriate examples, the paper, *inter alia*, presents how integration of ethics and geosciences is crucial innovation of the recent years.

Explaining innovatory sub-surface and surface phenomena of the Earth and the cosmos, attempt is made to present features of very wide-ranging processes of the Earth - past and present with an eye on resourcing tomorrow. Latest innovative Geo-scientific revelations made by advanced researches are found contributing directly to the momentous growth of geo-knowledge and its applications directly to meeting the societal needs through lead innovations in earth resources and energy-based industries, water scarcity and geo-hazards, apart from building major cities and infrastructure for urban population with geoengineering technologies. Advances in these areas are elaborately discussed with respective geo-techniques, especially related to environment protection and climate change, the most concerning aspects today for the human survival. More recent findings in geosciences comprise indications of early life in meteorites, water on Mars, search of mineral resources under ice sheets, catering for medicinal needs of the urban lot and home-remedies of the poor people with the development of discipline of Medical Geology. New geo-scientific concepts have helped building India and building career

both for male and female geoscientists. Great strides have been made in the geo-scientific arena to achieve the objectives of women liberation, gender quality and empowerment, and challenges and opportunities before the women geo-scientists during the discharge of their duties. These aspects are vividly brought up, stressing the point that every woman can be a lead geoscientist in maintaining the Earth Green. Lack of awareness programmes and inadequate syllabii in geology for schools are highlighted as they are considered serious handicaps to quality research and geo-technology innovations to be achieved in the future.

8. Morphodynamics of Delhi Region

Baleshwar Thakur

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The study deals with the evolution and structure of morphology of Delhi Region in relation to their controlling process comprising tri-junction of Aravalli ridge, Yamuna floodplains and approaching deserts. The study region is located at the intersection of Punjab-Haryana Plain, Upper Ganga Plain and Rajasthan Plain. It aims to: (1) investigate the nature of seismicity and its impact on the region, (2) classify and analyze the morpho-units of the region, (3) analyze the morphometric characteristics and with reference to spatio-temporal characteristics of floods, (4) classify and identify characteristics of floodplains of the Yamuna river, and (5) study the impact of falling groundwater level in the State.

The study area comprises of Delhi State, parts of Bagpat tehsil, Ghaziabad tehsil, Sonapat, Rohtak, and Jhajjar tehsils, parts of Gurgaon, and Ballabhgarh tehsil, and parts of Faridabad district. Physically, parts of the area is mountainous alluvial plain and another part is diverse and complex. The study uses variety of secondary data sources including Geological Map, Topographical Sheet, Satellite Imageries, Aerial Photos, Seismological Atlas, Central Groundwater Board, Central Water Commission, Indian Meteorological Department, Administrative Atlas of Delhi, and Geological Survey of India. Both statistical and cartographic techniques are used to arrive at conclusions. The study reveals control of lithology and structure of two physical units- the Aravalli hills to the west and the river Yamuna to the east. The region is highly vulnerable to disaster, especially floods, earthquake and lowering of groundwater level. The floodplains of the Yamuna river are classified into: Old floodplain, New floodplain and low-lying area; while the bedrock is classified into: Aravalli ridge, the piedmont plains and undulating to level plains of the Aravalli alluvium.

9. Himalayan Mountain Building, Tectonic Framework and Disaster Management in the Light of Innovative Earth Science

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Key Words: Himalayas, Plate Tectonics, Natural Hazards, Human survival, Global Climate, Innovative Earthscience

The Himalayan arc extends about 2,500km from northwest to southeast incorporating the loftiest peaks like Namcha Barwa(7,755m), Nanga Parbat(8,125m) and the Everest(8,848m). The width of the belt varies from 250-350 km. The mighty Himalayas and Karakoram, grew south of the Pamir embodying the largest concentration of lithospheric mass. The Himalayas consists of fascinating geological record of Precambrian to present and terminates both east and west with spectacular syntaxial bends.

The collision of India with Asia (50-60 Ma) is the most profound tectonic event to has occurred in the past 100 Ma. It is responsible for the upliftment of the Himalayas and Tibetan plateau.

Thus resulting changes in the earth orography and climatic changes related to collisional events.

The uplifting events in the Himalayan region began mainly in the Miocene and Pliocene period. An uplift of the rocks of about 4000 m during last 3 Ma has largely shaped the present topography.

The collisional events have been responsible for geological, geochemical and global climatological consequences of global extent. The uplift process is still going on with the approximate rate of 1 centimeter per annum with continued

erosion and denudation. The eroded material from its rugged topography is repeatedly and regularly being shed into depositional setting within the Himalayas to Bay of Bengal and Arabian sea by youthful rivers drainage network.

The Himalayas are geodynamically very active area. Due to high relief and active upliftment the rate of natural erosion is remarkably high. In addition, the generally folded, faulted and fractured nature of rocks in the Himalayan area and the high rate and intensive rainfall make many parts of the Himalayas susceptible to erosion and landslide. In parts of high to lesser Himalayas, a characteristic gradient in landslide frequently can be observed from the lower slope to Upper slope of the valley. The Upper slope representing an older geomorphological surface are mostly geochemically weathered. Granite and gneiss in such areas have sugary appearance to a substantial depth and show very low level of stability. Construction of roads though such areas can be hazardous. Often the geological faults zone also create a zone of crushed material along shear. Removal of vegetation cover also create erosion rate dramatically in areas where fault scrap.

Overlooking relatively narrow valley, the landslide has potential to block and dam the river course, flooding the valley with creation of temporary lake. These lakes often burst and cause the flash flood in the areas.

The construction of road in the mountain region has often caused the instability of slopes. Landslides are very commonly caused due to construction of dams and bridges. A systematically large scale geologic cum structural- digital map is necessary before taken up such projects.

Earthquakes are very common in high stress areas of central and syntaxial belts of Himalayan region. We have seen the devastating effects of earthquakes recently in the Himalayan region of western syntaxis in Kashmir

The sudden flash flood caused by cloud burst has become a common phenomenon viz.Ladakh.

The Global climatic change resulting warming responsible is responsible of recession of glaciers at alarming rate is serious matter of concern for the human survival in the Indo Gangetic plain.

The stress and strain caused due to relative motion in the subduction zone are responsible for frequent earthquake and tsunamis.

The matter is getting rather simplified to take precaution with the innovation techniques viz.GPS data system and seismological laboratories being established in the sensitive areas.The satellite data has made much simpler the planning with geoinformatics techniques.More and more information received by innovation in earth science would reduce the hazard management and loss of human life, and bringing more prosperity.

10 Tsunami Simulation in Indian Scenario and a Possible Approach for Early Warning

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Indian coast is vulnerable to tsunami hazard mainly from two sides due to major earthquakes. These are Andaman-Sumatra subduction zone towards east and Makran subduction zone towards west. There is historical evidence of tsunami hazard from these regions in past and current seismic activities in present. The disaster can be particularly hazardous to nuclear power plants as in the case of recent Japan earthquake which can further trigger huge calamities and also for the large population in the coastal regions. The case

studies of tsunami modeling and simulation will be discussed to highlight the scenarios from both of these regions in terms of wave heights, inundation and directivity of the waves. Also, a novel approach based on wavelet based processing of seismograms will be discussed for tsunami warning, which has advantages over the conventional way of warnings.

11 Active Deformations in Manipur: Multidisciplinary Evidences

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Northeastern part of the Indian subcontinent is seismically active region with excessive rainfall and frequent landslides, which cause disruption of the road networks for couple of months in every year. The region has a typical morphotectonic setup where many active thrusts and faults have affected the landforms as well as the major part of the terrain. A prominent creeping strike-slip fault, named Chrachandpur Mao Fault (CMF), trending N-S, is one of the triggering factors for frequent landslides, creeping low magnitude earthquakes. The life line of Manipur, national high way NH39 traverses through this fault in Manipur, hence the traffic is disrupted during the monsoon season. Based on the GPS campaign mode studies on western and eastern sides of the CMF, it is observed that there is a change in the crustal velocities from 16-22 mm/yr in east to 33-42 mm/yr in the west. Micro-deformations are also observed; the displacements along the vertical, N-S and E-W components are -0.111 mm/yr (downward), 0.03mm/yr (north) and -0.011 mm/yr (west). The net displacement is 0.126 mm/yr with an azimuth of N 85⁰ and dipping 13⁰ towards west. Neotectonic development along the CMF with the GPS measurements suggest an aseismic nature of the fault with dextral component. Fault plane

solutions of the earthquakes show northerly directed principal P-axis indicating the extension (T-axis) along east-west. The resulting creeping of micro-deformation towards the western slopes of the terrain is aligned with the principal T-axis. The creeping triggers the microseismicity as well as the landslides along the CMF.

12 Crustal deformation studies in India using GPS

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Geodetic studies in India were initiated more than 200 years ago by Survey of India. During that period the British Government emphasised on making accurate maps for easy accessibility and navigation. For the purpose they initiated Great Triangulation Survey during 1860s. The network was occupied several times since then. In the intervening period several large earthquakes occurred which distorted the network. Probably the first use of geodetic method in seismology was demonstrated when levelling was used in estimating the crustal deformation due to the 1819 Allah Bund earthquake in Rann of Kachchh. Though afterwards several earthquakes occurred, either no data exist or these earthquakes occurred far from the GTS network. However, occurrence of 1897 Shillong Plateau earthquake locally distorted Assam GTS network and these data were later on used to investigate rupture processes of this earthquake. The leveling data along the Saharanpur-Mussorie line helped in inferring rupture size of the 1905 Kangra earthquake. The leveling lines in the Ganga Plains documented subsidence due to the ground effects caused by the 1934 Bihar-Nepal earthquake. Similarly, geodetic data in the region of 1935 Quetta earthquake revealed that the earthquake produced about 50 cm of vertical deformation. Unfortunately, corresponding to the 1950 Assam

earthquake, the latest in the sequence of the great Himalayan earthquake, no geodetic data (or any other quantitative observations) are available to constrain the rupture.

By the end of last decade, GPS network in India expanded dramatically and the earthquakes that occurred after that, like the 2001 Bhuj (Mw 7.6), 2004 Sumatra-Andaman (Mw 9.2) and 2005 Kashmir earthquakes (Mw 7.6), were nicely monitored using GPS. Each of these earthquakes caused discernable coseismic changes at the nearby (even at far-field locations in at least one case) GPS sites. Observations of coseismic deformation helped in constraining the rupture characteristics of these earthquakes. Continued measurements after these earthquakes helped in understanding the mechanism of postseismic deformation. The measurements in the Himalaya, including the Indo-Burmese arc helped in understanding the mechanism of crustal deformation and its variation along the arc. GPS sites in the stable continental region have helped in understanding the Indian plate motion and assessing the stability of the region. Significant results related to the crustal deformation will be discussed during the presentation.

13 Paleoclimatic implications of the Paleosols occurring in the early sequences of the western Himalayan foreland basin

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The Paleogene sequences of the western Himalayan foreland basin contain diagnostic paleosols. They are Oxisol, Histosol and Calcisol in ascending stratigraphic order. They can be used broadly to interpreting latitudinal position and climatic history of the northern part of the Indian subcontinent. The Oxisol (bauxite) is of sedimentary origin and shows features suggesting reworking of the

precursor bauxite. The bauxite is constituted of gibbsite, goethite and kaolinite and shows CIA values close to 100. This suggests intense weathering of the parent rock. The behavior of trace and rare earth elements suggests that the Oxisol was produced by weathering of a basic rock under warm and humid climate. The Histosol is characterized by bright, moderately dull and dull bands associated with carbonaceous shale. Histosol (coal) contains woody structures with a dominance of vitrinite maceral. The Histosol is interpreted to have originated from an undisturbed peat developed in a swamp in the intertropical convergence zone.

Up-section, the Calcisol (calcretes) occurs within the brown coloured mudstone host where profile development is recorded up to stage 4. The nodular calcrete varieties of stage 2 and 3 dominate over others that occur repeatedly in many coeval sections, while the laminar calcrete of stage 4 occurs in only one profile. Both alpha and beta fabrics are recorded in these calcretes. The alpha fabric elements are mainly micro-nodules, pellets, corona and birds-eye structures while beta fabric elements are rhizoliths, alveolar septal fabric, filamentous structures associated with borings, rod-shaped crystals, microbial mats and *Microcodium*-like structures. The rhizoliths, alveolar septal fabric and filamentous structures around borings formed in root-fungal-bacterial association in the vadose zone. Microbes were instrumental in precipitation of calcite in the form of microcrystalline crystals and mats, and the *Microcodium*-like structures. Fungal dissolution and bacterial precipitation also precipitated rod-shaped crystals and enabled spar-micritization of calcite. The Calcisol has developed under a semi-arid to arid climate in the subtropical climatic belt.

The occurrence of diagnostic paleosols in the Paleogene sequences suggests geomorphic stability in the depositional basin and very low sediment supply from the orogenic belt during their development. They also suggest that they formed in different climatic belts as a consequence of latitudinal shift during the northward movement of the Indian plate in early part of the Cenozoic Era.

14 Diffusion Modeling Studies in Minerals and its Geological Applications

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Keywords: Diffusion modeling, Fick's Law, Cooling rates, Exhumation, Garnet, Duration of Geological processes, Himalayas, Alps, Antarctica

Diffusion in the solid state is a widespread process that has many attributes, which allow it to function as a clock for measuring durations of a variety of terrestrial and planetary processes. The diffusion clock can measure the duration of very short (days) as well as long (millions of years) processes, and its functioning is independent of the age of the material. This makes it particularly valuable for studying short processes in the early history of earth and the solar system. Determining durations of the geological processes is one of the major goals in earth sciences. Records of incomplete diffusive equilibration preserved in minerals are suited for the purpose of unraveling timescales of a variety of geological processes.

Modeling of concentration gradients in minerals produced by diffusion is emerging as a powerful tool for quantification of estimation of rates of tectonic processes. Some of the first quantifications of the speed with which ultrahigh pressure rocks were buried and returned to the surface came from diffusion modeling studies. A dynamic environment is characterized by changes in pressure and temperature. Rocks and their constituent minerals respond to these changes in intensive variables (P, T,

f_{O_2} , $f_{\text{H}_2\text{O}}$ etc.) through a change in the stable compositions of minerals, or the stability of minerals themselves. Breakdown and formation of new minerals at the expense of existing ones are accompanied by changes in composition that occur over a range of values of the intensive variable concerned. Zoned crystals are preserved in rocks, when the rate of homogenization is not fast enough relative to other dynamic processes (e.g. heating/cooling, crystal growth/dissolution). Classic examples of such zoned crystals are plagioclase in igneous rocks (diffusion rate much slower than rate of crystal growth/dissolution) and garnet in metamorphic rocks (diffusion rates slower than rates of growth/dissolution or heating/cooling). The extent of diffusive approach to equilibrium that has occurred in a given mineral then provides information about the duration of the process, if the rates of diffusion (i.e. diffusion coefficients) of elements/species in minerals are known. The process of diffusive homogenization is often the slowest or rate limiting step in the overall process of transformation of minerals and determination of this rate then amounts to the determination of rates of geological processes.

Determining the duration of any process rely on a kinetic process of some sort in the broadest sense because kinetics is the physiochemical branch of study that provides information on time. Frozen states of disequilibrium, combined with known kinetic rate laws and rate constants provide method of determination of time.

Unlike any other kinetic process, diffusion obeys only one, very specific mathematical law that is obtained by applying the continuity condition to Fick's law and this is well known in the field of mathematics as the diffusion equation, in one dimension it is written as:

$$\frac{\partial C}{\partial t} = \frac{\partial}{\partial x} \left(D \frac{\partial C}{\partial x} \right) \quad \dots (1)$$

In order to apply above diffusion equation for the determination of the time span of geological processes, several steps are necessary. In any diffusion modeling approach, the terms within the brackets on the right hand side of Equation (1) are the input and time (i.e. duration) is the output that is sought. The concentration profile or gradient ($\partial C / \partial X$) is the measured input from a particular sample and the diffusion coefficient, D, is the rate constant determined in the laboratory. The actual operation of extracting time using these pieces of information involves solving the differential equation embodied in Equation(1). This equation can be solved analytically or numerically. Numerical methods have the advantage of being more easily adaptable to geometries and initial conditions corresponding to specific systems. Case studies of diffusion modeling and its geological applications are discussed.

15 Nano-materials in Earth and Environmental Sciences for societal prosperity and its sustainability

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Near subsurface Earth science research provides knowledge and data essential for developing policies, legislation, and regulations regarding land, mineral, and water resources at all levels of government. Earth and environmental science research will stimulate innovations that fuel the economy, provide security, and enhance the quality of life. Earth scientists have a better understanding of many of the factors that can affect sustainable development, energy demands/consumption, and anthropogenic effects over Earth's systems. Earth science is also an inevitable branch of science that offers job opportunity, because the demand for resources that exponentially increases in the next decades is dependable upon the trained earth scientists. Nano-crystalline materials and nanometer (10^{-9} meter)sized porous media such as carbonaceous matter, metal oxides , alumino-silicates such as zeolites and clay minerals are very ubiquitous in natural environments and play a vital role in our daily life, since they play a major role as invaluable economic resources.

In nature, nanocrystalline minerals are formed in the environment as a result of microbial activity, inorganic precipitation reactions and chemical weathering, that are relevant to a new emerging area of Earth's shallow sub surface science. Recently,

Department of Science and Technology, Government of India has also initiated a new thrust area in earth science "Science of Shallow Subsurface" , as this field deals with the quality of land (soil), resources, air, water, and human health. In this talk, the geological occurrence, and applications of Nanomaterials that are relevant to the mineral exploration and environmental science are discussed with specific examples like : natural fullerenes from different geological environments including mine waste; nanocrystalline transition metal oxides ; and nanocrystalline clay minerals like ferrous saponite with an application to environmental science; and naturally occurring ferrous chamosite , a marine clay mineral with an application to Pharmaceutical industries.

16 Quantification of Microcrack Anisotropy using Fractal Based Methods – A Step towards Mineral Exploration

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Key Words: microcracks, fractals, mineral exploration, anisotropy quantification, quartzite, experimental deformation.

It is known that fractures in natural rocks tend to have azimuthal anisotropy, which plays an important role in channelizing mineral-bearing fluids, geothermal energy etc. The orientation of fractures and their anisotropy also varies with changing stress regimes as exploitation of minerals (including hydrocarbons) progresses. Therefore, quantification of fracture anisotropy can be

useful in mineral resource applications. In the present study microcrack patterns are quantified in quartzites before and after experimental deformation. Fractal (ruler) dimension analysis is performed to demonstrate the fractal behaviour of microcracks traced from SEM images. The anisotropy of microcrack patterns is quantified using the modified Cantor Dust method. A comparison of data from the experimentally undeformed and deformed samples reveals that the adopted methodology is sensitive to quantify changes in microcrack patterns. The first results are promising and it is suggested that such quantification may be useful in future in the study of mineralized zones as well as in mineral exploration and exploitation.

17 Applications of Space Technology in Disaster Management

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India has been traditionally vulnerable to natural hazards on account of its unique geo-climatic settings. It is frequently affected by disasters such as tropical cyclones, floods, drought, earthquakes, landslides, forest fires, oil slicks and occasionally tsunami. Besides slow yet significant hazards like coastal erosion, desertification, land degradation, glacial retreat and sea level rise are another threat our country faces.

Disaster management is the key issue and the country's scientific and technological achievements have a major role to play in it. Disaster Management aims to minimize loss of life, property and environment. Space provides scientific and technological ways and means in all stages of Disaster Management. Disaster Management involves effective Preparedness, Response, Rehabilitation, Reconstruction and Mitigation for a specific disaster

and improvement at each component level with recurrence of that particular disaster. Communication satellites help in early warning and relief mobilization. Earth observation satellites provide reliable database for disaster prevention, mitigation and preparedness programmes. Geographic Information System (GIS) provides additional tool to integrate large spatial and aspatial geo-referenced data sets for improved disaster management solutions. A synergy of Earth Observation, GIS and communication technology is playing a major role in effective disaster management.

Realizing the role of space technology in various components of a disaster management cycle, Department of Space, Indian Space Research Organisation (ISRO) has launched Disaster Management Support (DMS) Programme as one of its key programs. Constellation of Indian satellite Series (IRS, Resourcesat, Cartosat, Oceansat, INSAT, GSAT) provides quick and reliable services in all phases of disaster management. The DMS program focuses on integrating the space technology inputs and services, on a reliable and timely basis through various units of ISRO. Space based inputs are operationally provided to various state and central user agencies by Decision Support Centre of National Remote Sensing Centre (NRSC), Hyderabad for various natural disasters in particular for floods, drought and forest fire. Space Applications Centre, Ahmedabad provides R&D support to DMS Programme by identifying and carrying out pilot studies related to use of space technology for early warning of various natural disasters, development of Airborne DM-SAR and satellite based emergency communication systems. Indian Institute of Remote Sensing, Dehradun supports capacity building besides R&D for various natural geo-hazards. Some of the major disasters occurring frequently in India and use of space technology in disaster monitoring, mitigation and early warning are discussed in this paper.

18 Innovative Earth Science For People's Prosperity: A Visualization

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The Earth System Sciences as a discipline, studies empirically – the earth in its varied forms. And thus becomes multi-facets science correlated to sister sciences, like Geology, Geo-Physics, Geomorphology, Pedology, Petrology, Geography, Anthropology, Hydrology, Climatology, Oceanography, Environmental Science, etc. like these branches of knowledge, the Earth Science focuses on the universal fact – ‘ Nature And Man Relationship’ with changing modes of researches in the micro specialized forms as per demands of Science, Technology and the Society in tune with time and space factors for the sake of progress and prosperity of the mankind. The present attempt however, is to highlight the contributions made by the discipline in the services of human society from its inception, initially it brought into the knowledge of the society about the Earth- as a planet, about its origin, of its age, its relations with other celestial bodies, its internal and external structures, its surface configuration – different landforms under different geographical conditions, etc. the explorations of new locations of human habitat –favorable or no favorable came under the preview of academic pursuits followed by the system of resource appraisal of all types- biotic and abiotic etc. the thrust of research on the metallic and non metallic minerals along with the conventional and non-conventional sources of energy, their mode of occurrences, reserves, their spatial distribution, their transportation and uses etc. has revolutionized a new way of life of industrial and urban culture throughout the world. Moreover, the studies of soil and water resources managements for better and efficient utilization of hydel power and agricultural productions for the socio-economic upkeep and the sustenance of burgeoning population became another hallmark in the prosperity of the modern society. Besides, the discipline extends its role to know *the natural and man-induced calamities*, locates the prone-areas and suggests measures to minimize and mitigate their effects.

The issue of climate change linked with global warming leading to serious consequences has become the latest frontiers of new research paradigm of the discipline to save our mother planet and its biodiversity. All these justify the Earth Science as a dynamic and innovative discipline, which advances with developing techniques and modernity. *The uses of Remote Sensing, GIS and GPS* etc. in finding our the minerals and forest prospecting, preparation of land use inventories for agricultural developments, forecasting of weather, and natural hazards, *using coupled ocean atmosphere general circulation model* etc., have made positive impacts on human betterment. India, like other development and developing countries has also adopted the *Earth Science as academic pursuits of excellence*, which has been contributing the nation in its national and regional planning, prospects. This is very evident from this fact that the Earth System Sciences (ESS) has established itself *as a formative and effective section in the curricula of Indian Science Congress* organized every year with its national academic agenda. Above hundred earth scientists congregate and participate in the national forum to share the national goal of progress and prosperity, further, the discipline is ever prepared to continue its mission in the services of the society with its budding posterity.

**19 Innovative Earth Science for People's Prosperity
Innovative mining policy and technology for people's prosperity**

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Key words: Mineral resources, Lithium, battery, energy conservation

Mineral resources have contributed immensely for a nation's prosperity. This contribution for the symposium highlights the importance of mineral resources for local development and how a technical breakthrough in energy sector and a legislation can lead to energy conservation and people's prosperity. New policies and practices are explored across the world

to ensure that mineral wealth can be converted into sustainable development benefits for local communities. The Govt of India is enacting a new law for mining companies to set aside 26% of their profits for local communities. When implemented, this will immensely benefit the tribal population and rural development.

Innovative methods are employed to minimise use of petrol and diesel devices with a battery powered alternative. The dream of energy -secure and environment-friendly future can be realised only through the battery. Technology that will help produce maximum power with minimum battery weight is the industry's main challenge. Lithium-ion is considered ideal for batteries. Being the lightest metal and the least dense solid element, lithium makes the battery pack portable. Many companies are now trying it out in electric cars. Lithium carbonate made from lithium chloride exists as a soluble in brine lakes. South America dominates in lithium production. Chile and Argentina are the leading producers. Bolivia has about half of the world's lithium reserves. With technological innovations the future of South America may soon change as oil brought prosperity to West Asia.

20 Ecofriendly Geotextile: An Innovative Polymer Substitute

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Geotextiles are generally made from fibrous material of various substances in the form of individual fibres, filaments, yarn, tapes etc. Geotextiles are being utilised for very long periods. Mainly, synthetic geotextiles made up of polymers dominate the geotextile market but considering ecofriendly nature of natural fibre based geotextiles are getting place in the market. Fibre based geotextiles are decomposed after some time and therefore of specific use.

Sisal, Jute and Coir fibre based geotextiles are being used in India. All these three types of geotextiles have their own properties and therefore specific application.

In the present paper, comparative properties of synthetic and natural fibre based geotextiles have been evaluated and efficiency of natural fibre based geotextiles has been assessed mainly for soil and water conservation. It has been found that the sisal based geotextiles are more suitable amongst sisal, coir and jute geotextiles.

21 Earthquakes in Varahamihira's Brihatsamhita- Correlation with Modern Science

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Prediction of Earth Quakes has been a challenge for the modern science and many alternative approaches for this purpose are being pursued though out the world. Ancient Indian scientific literature, though not available comprehensively, is showing rays of hope in this field, since their approach of dividing the earth's layers classifying the occurrences of Earth Quakes, application of inter disciplinary approaches etc., seem to be very logical and practical. With this hope, a study of the available ancient Indian literature, including Brihatsamhita is taken up and an attempt is made in this article to correlate their prepositions with the modern theories and planatorium software, to pave a way for a more in depth study.

CLIMATE SCIENCE

1 **Speleothems, Holocene Paleoclimate , Monsoon and Tectonic Implications : Evidences From Nw Himalaya and the Shillong Plateau, NE India**

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Keywords : Stalagmites, Paleoclimate, Monsoon, Himalaya,
Shillong Plateau,
Meghalaya, stable isotopes, tectonics

Himalayan speleothems may provide important record of Holocene palaeoclimate and palaeomonsoon since they are not subjected to diagenesis and erosion. Miocene to Holocene palaeoclimatic , paleoceanographic , palaeomonsoonal studies from the tropical and monsoonal regions of Indian ocean , subcontinent and SE Asia has been reviewed. Stable oxygen isotopic variation in speleothems especially stalagmite growth laminae is used for interpreting the amount of rainfall. Speleothem deposits have been studied from the Kumaon and Garhwal Himalaya in the NW and Shillong Plateau in the NE region. These caves are located in the Sahastradhara and Tapkeshwar areas of Dehradun, Prakateshwar cave in Uttarkashi, Chulerasim near Chaukhutia and Patalbhuvaneshwar near Gangolihat town of Almora and Pithoragarh districts of the Kumaon Himalaya. In the NE, the caves have been studied from Mawsmi, Mawmluh and Mustos areas in the East Khasi Hills, South Shillong Plateau, Meghalaya. All these caves are located in the high monsoonal region therefore, it is quite significant to study the strength of Indian Summer Monsoon (ISM) and decadal scale seasonal variations. It is also attempted to

establish a relationship between the climate- monsoon and tectonics with the present study of the speleothems.

2 Multi-hazard Risk Zoning Using Relative Vulnerability and Human Risk to Natural Hazards

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Risk refers to expected losses to a particular hazard. Losses may be estimated in term of loss of human life, Livestock death, building damages, crop-loss, loss of livelihood and loss of property which are mostly recorded by the state Govt.s and are available for public use. At the international level economic losses are not used for measuring risk because of different purchasing values in different countries but human life lost is chosen for this because it is subject to less variation across the countries.

Based on physical exposure to the floods in India, the states coming under the very high category (> 1 million people/Year) are Bihar, Assam, Orissa W. B, Karnataka, M.P, A.P, H.P and Gujarat. The states coming under the high category (0.5 to 1million people/year) are U.P, Delhi and Arunanchal Pradesh. But as per the disaster risk index the states under the very high cataegory are Maharastra and Nagaland considering human death due to floods per million exposed population where as considering property loss per milliom exposed population the states are TN, Kerala, Uttranchal.

The study reveals that there is an increasing trend of the human vulnerability due to the natural hazards in spite of various preventive and mitigation measures. The coastal districts which were traditionally known as the flood and cyclone prone districts are

showing relatively lesser vulnerability in comparison to the western districts where the natural hazard risk is high. The findings also point towards the fact that there is a need to track the relationship between Development Policy and Disaster Risk. Prospective Disaster Risk Management should incorporate Disaster Risk Reduction as a part of an on going planning & development process.

3 Modelling of rainfall and Extreme Temperature Variability Records using the EOF spectra and Artificial Neural Network

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Keywords: Rainfall, Temperature, neural network; MLP, Prediction
Keywords: Hybrid Monte Carlo, Bayesian neural networks, Trees-
ring Temperature variability, Himalaya, Nonlinear model,
prediction.

Understanding the different natural frequency modes from a complex rainfall and temperature records is essential for making future prediction. Here we investigate the empirical orthogonal function (EOF) and spectra of the all India average rainfall and temperature data recorded with monthly resolution for a period of 100 years from the Andhra Pradesh. Spectral analysis of first principal component (PC1) reveals maximum variance with the dominance of significant solar cycle. Similar spectral analysis of PC2 and PC3 reveal inter-annual oscillations peaking at period range matching with the global aspect of El Nino-Southern oscillation phenomena.

In order to predict and understand the spectral complexity of these records a novel technique based on the artificial neural network (ANN) theory is employed to these data. Prior to application of these method on actual data the robustness of ANN algorithm was tested on the well known chaotic, first autoregressive (AR) and random models and then applied to model the rainfall and temperature data. These Data are analyzed by using the well known Levenberg–Marquardt (LM) feed-forward back propagation network for training, validation and testing. For each network, fraction of variance (R^2) and root-mean squared error (RMSE) values were calculated and compared. For modelling the actual data, optimum network parameters are chosen appropriately and then cross-validation test is performed to ensure the generalization skill of the network on the data set. Finally, prediction results based on the ANN model is compared with the (AR) linear models results. The comparative results show the ANN based analysis makes better prediction than the AR models. The results of the analysis show that the ANN approach is fast and efficient method for modelling large amount of data. The new ANN modelling approach provides a viable a tool for such data modelling and could be exploited for the modelling other kinds of environmental data.

4 Assessing the Impact of Climate Change on Hydrological Regime of Chenab Basin in Western Himalayas

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Now-a-days the sign of climate change and its impact is revealing on different natural and man-made systems, in one or other ways and accordingly, this impact is significant on the water

resource system. The present study mainly deals with assessment of the climate change impact on the Chenab basin. Projection of the future climate variables from 2011 to 2040 was done by using General Circulation Model (GCM) which is considered as the most advanced tool for estimating the future climatic condition. Statistical Down Scaling Method (SDSM) was applied in order to downscale the climate variables at catchment level. The projected maximum temperature from 2011 to 2040 showed an increasing trend for all time horizons. Comparatively, A2 Scenario which is the high emission scenario prevailed higher change in maximum temperature trend for the months of February, April, June, July August, November, and December than the B2 (low emission) scenario. And relatively, a larger absolute monthly difference from the baseline temperature was found at the months of May, June July and August. The calculated minimum temperature from 2011 to 2040 showed an increasing trend in all future time horizons for both A2 and B2 Scenarios. The increment for A2 Scenario is greater than B2 Scenario because A2 Scenario represents a medium high scenario which produces more CO₂ concentration than the B2 Scenario which represents a medium low Scenario. The calculated result shows increase in the minimum temperature trend during the months of February, June, July, August and October according to A2 Scenario. The absolute monthly difference from the baseline minimum temperature values for the months of February, June, July, August and October are 0.35, 0.29, 0.28, 0.33, and 0.41 respectively according to A2 Scenario and according to B2 Scenario absolute monthly difference from the baseline minimum temperature are 0.14, 0.19, 0.22, 0.17, and 0.31 for months February, June, July,

August and October respectively. Precipitation showed an increasing trend for the months of March, April, September and October from the baseline period. According to B2 scenario the precipitation shows maximum increase during the months of March and October as compared to A2 Scenario and rest of the months precipitation decreases from the baseline period.

A hydrological model, HBV was utilized to simulate the water balance. The performance of the model was assessed through calibration and validation process, resulted $R^2=0.88$ (for sub basin 12) and $R^2=0.86$ (for sub basin 15) during calibration. During validation $R^2= 0.95$ (for sub basin 12) and $R^2= 0.98$ (for sub basin 15). The results obtained from this investigation indicate that there is significant variation in the seasonal flow. In June, July, August there was reduction in discharge by 5.8%, 6.4%, and 6.4% respectively according to A2 scenario and 3.16%, 6.9% and 5.2% respectively according to B2 scenario for the calculated time period 2011 to 2040.

5 A climate record from Lake Riwasa, Haryana, India: A Stable Isotopic Study

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Riwasa is a dry lakebed that once existed in a very steep rainfall gradient (200-600mm) near some of the important Indus Valley sites in this region. When the lake contained water, its hydrology was likely sensitive to changes in the balance of

precipitation and evaporation. It is thus well suited for a paleoclimatic study in relation to the cultural evolution of the Indus Civilization. The CaCO_3 and stable isotopes clearly shows three periods- a deep permanent lake bound by two ephemeral shallow lake. The radiocarbon dates indicates, wet phase starts at about 8000 yr BP, with the increasing monsoon strength.

6 Carbon capture and storage technology: Geosequestration

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Key words: Geosequestration, Geophysical techniques, Carbon capture and storage technology, Underground coal gasification

Geoengineering is the idea of applying planetary engineering to Earth. Geoengineering would involve the deliberate modification of Earth's environment on a large scale "to suit human needs and promote habitability". Some geoengineering techniques are based on carbon sequestration. These seek to reduce greenhouse gases in the atmosphere directly. These include direct methods (e.g. carbon dioxide air capture) and indirect methods (e.g. ocean iron fertilization). These techniques can be regarded as mitigation of global warming. Alternatively, solar radiation management techniques (e.g. stratospheric sulfur aerosols) do not reduce greenhouse gas concentrations, and can only address the warming effects of carbon dioxide and other gases; they cannot address problems such as ocean acidification, which are expected as a result of rising carbon dioxide levels. Geosequestration is often assigned as carbon capture and storage (CCS), carbon capture and geological

storage (CCGS), carbon dioxide capture and storage, or clean-coal technology. Geological storage (Aquifer storage) Underground CO₂ storage of any kind must take place in sedimentary rocks. Only they are porous enough to have storage capacity of interest. Storage of the CO₂ in underground sites beneath a layer of impermeable rock (cap rock) which acts as a seal to prevent the CO₂ from leaking out is the most popular option at present. There are three main types of proposed underground storage sites: Deep saline water-bearing formations (saline aquifers), Depleted oil and gas reservoirs, Oil reservoirs that may be used for CO₂ Enhanced Oil Recovery (EOR), Deep coal seams containing methane (Enhanced Coal Bed Methane Recovery (ECBM)), Deep ocean storage. Methane Hydrate(white gold) Reservoirs – CO₂ hydrates are more stable and if CO₂ is injected into a methane hydrate reservoir, it will displace the methane hydrate by capturing the water from the methane hydrate and releasing the methane. The issue is low permeability because the hydrates are solids filling the pore spaces. Microbial Enhanced Methane Production- Technology to enhance biogenic methane production, or methanogenesis, in deep unmineable coal beds. This would potentially have numerous benefits:accelerating methane production in naturally occurring coal bed methane reservoirs, converting sequestered CO₂ to methane by injecting CO₂ or flue gas into coal beds to enhance CBM recovery, increasing shale gas recovery. Geophysical techniques employed for the risks assessment of CO₂ storage in geological reservoirs; CO₂ plume location; 2-D, 3-D and 4-D seismic reflection surveys, Wellbore to surface and cross wellbore seismic measurements, NMR logging, Electro seismic(ES), Electrical and electromagnetic methods, Land surface deformation using satellite imaging (InSar) or tiltmeters, Gravity, Reservoir pressure monitoring, Wellhead and formation fluid sampling, Natural and introduced tracers.

7 Climate Change

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The Scientific concern about global climate change arises from the buildup of greenhouse gases in our Atmosphere. Climate change focuses on human activities, because these activities are suspected to have caused the large increase in Atmospheric Green Gas concentrations since pre-industrial times and they are predicted to cause continued increases in the future. The actual size of the predicted increase depends on the particular Scenario of changes in population, income and technology.

Carbon Dioxide in the other Green House Gases moderates the current climate. The Concern is that higher level of Carbon Dioxide will change future climate possibly Making it Warmer some of the more drastic predictions of environmental change include large Scale Forest Dieback, Sea level raise, alerted Agricultural productivity (Higher or Lower depending on the region) and other impacts.

The available data indicate that

- 1) Global Carbon Dioxide emissions have risen 3.3% per year since 1950.
- 2) Atmospheric concentrations of Carbon Dioxide have risen 0.4% per year since 1972.
- 3) Global Average temperatures have increased 0.3 to 0.6 Degrees C since the late 1800's.
- 4) The 1900's are at least as warm as any century since the earliest evidence (1400's)
- 5) Nighttime temperatures over land have increased more than daytime temperatures.
- 6) Global sea level has risen between 10 and 25 cm (4-10) inches over the past 100 years.
- 7) Dust and sulfur dioxide (from coal used to produce electricity) can reduce the warming influence or carbon dioxide in some locations).

Alternative options for reducing Carbon dioxide emissions:-

- Energy conservation and efficiency improvement.
- Switching to less carbon intensive fuels.
- Install renewable energy technologies.
- Reduce tropical deforestation.
- Establish forest plantations.

8 Monitoring of Vertical Aerosol Flux using Lidar-Radar Observation over Pune, India

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Keywords—Aerosol, Air Pollutants, Human Health, Climate, Mass flux, Positive flux

Knowledge on the source/sink strengths as well as mixing mechanisms of air pollutants is particularly important due to their effects on human health and climate. Moreover, the exchange processes of aerosols and air pollutants between the surface and atmosphere play a vital role in our quality of life. In order to understand of these surface-atmosphere interaction processes an analysis of vertical aerosol mass fluxes has been carried out at the Indian Institute of Tropical Meteorology (IITM), Pune (18.32°N 73.48°E, 559 m AMSL), India. The vertical exchange/transport was measured for the period 2005-2006 with the profiles of aerosols and vertical wind velocity respectively derived by a bi-static Argon-ion lidar and a UHF wind profiler, latter is available with the India Meteorological Department (IMD), Pune, and a few hundred meters away from the IITM. Study reveals the positive/negative aerosol mass flux, positive flux (average value of $13.32 \text{ cm}^{-2}\text{s}^{-1}$), indicating

upward transport of aerosols (cleaner air) in the month of June, while negative flux with average values of -0.15 and $-3.39 \text{ cm}^{-2}\text{s}^{-1}$, implying downward transport of aerosols (dirtier air) in the months of August and September, respectively. Also, these features are found to corroborate the results of wind shear (height gradients of horizontal as well as vertical winds) analysis, and local meteorological/terrain-induced boundary layer evolution.

9 Simulation of convective rainfall events associated with monsoon system using WRF-3DVAR analysis system

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Key words: South-west monsoon, mesoscale model, data assimilation, convective systems

Most of the rainfall along the Indian peninsula during the south-west monsoon (SWM) occurs in association with convective activities over the Arabian Sea and the Bay of Bengal (BOB) that propagates into the peninsular. These rainfall activities are usually associated with mesoscale convective systems (MCSs) embedded in large scale monsoonal circulation exerts a significant control on the temporal and spatial distribution of monsoon rainfall. Timely and reasonably accurate prediction of these convective activities can significantly reduce the loss of lives, damage to properties and an awareness of the events to the general public as well as the planners for scheduling their action to a great extent.

There have been considerable improvements in the field of mesoscale prediction over past few decades using high-resolution state-of-art mesoscale models and these models are recently proved

to be more successful for the prediction of heavy rainfall events associated with convective activities as well as synoptic systems. The skill and efficiency of a mesoscale model mostly varies with the quality of initial values, accuracy of parameterization of physical processes and horizontal and vertical resolution of the model. Commonly used low-resolution reanalyses/analyses are hardly able to capture the prominent features associated with organized convective processes in a large scale monsoonal circulation. The need of using a mesoscale model with data assimilation system is recognized. The Weather Research and Forecasting (WRF dynamical core ARW) modeling system along with three dimensional variational (3DVAR) data assimilation technique is used to address some important aspects towards the improvement of simulation of the convective rainfall events during SWM season.

For this purpose, two sets of numerical experiments, with and without data assimilation are conducted using WRF-3DVAR analysis system for simulation of rainfall events associated with monsoon system. After the successful inclusion of additional observational data using the 3DVAR data assimilation technique, the resulting reanalysis is able to successfully reproduce the structure of convective organization as well as prominent synoptic features associated with the weather systems. The location and evolution of the convective systems are better simulated in the 3DVAR experiment as compared to the CNTL. The results demonstrate that the improved initial conditions of the mesoscale model enhanced the location and amount of rainfall over the Indian monsoon region. Study results provide a positive proof of concept that the assimilation of the Indian observation data within WRF can help improve the simulation of intense convective systems influencing the large-scale monsoonal flow.

DEFORMATION AND TECTONICS

10 Structural features associated with the Pyrophyllite bearing rocks of Jamudih, Keonjhar District, Odisha.

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Key words: Keonjhar, pyrophyllite, plicative features.

Pyrophyllite (Al_2O_3 , $4SiO_2$, H_2O) is akin to Talc in respect of crystalline characteristics. Keonjhar District of Orissa accounts for a reserve of 8 million tonnes. In Keonjhar district, a 90 km long NNE-SSW trending pyrophyllite bearing belt is bounded by latitudes $21^{\circ}41'00''$ to $21^{\circ}41'24''N$ and longitudes $85^{\circ}-30'-40''E$ to $85^{\circ}-31'-40''E$ in Toposheet No. 73G/10.

The different planar features are bedding plane (S_1), foliation/schistose planes (S_1 and S_3) belonging to a tri-phase deformational framework. F_1 folds are tight isoclinal folds. F_2 folds are minor open folds developed roughly at right angle to the F_1 folds, which belong to Ramsay's class 1B and 1C type. The F_3 folds (open to warp folds $\langle D \Rightarrow 120^{\circ} \rangle$) belong to the last phase of folding history. In style they are symmetrical folds belong to class 1B of Ramsay. The present paper deals with the detailed account of folds and linear geometry. The planar and linear elements are mesofabrically analysed through β and π pole diagrams.

11 Modeling the Sonic Layer Depth in the Arabian Sea

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The speed of sound in sea water is dependent on the temperature, salinity, and the pressure. Sonic layer depth (SLD) obtained from vertical profiles of sound speed is an ocean parameter with important strategic applications. The present work attempts at modeling this parameter over the Arabian Sea from subsurface parameters like wind speed, peak insolation and oceanic heat loss at the ocean surface. SLD is obtained for a one year period and its seasonal variabilities are then studied. The work explores the possibility of modeling the SLD from surface parameters alone for the first time using a numerical model in the absence of in situ measurement of sound speed.

12 State of Stress under Pre and Post Seismic Scenario along the Rupture Area due to Great Mw 9.1 Sumatra-Andaman Earthquake of 2004 and its Kinematic Implications

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Key Words : Sumatra; Stress inversion; Sunda plate; Subduction;
Dip-angle

The Great Sumatra-Andaman Earthquake occurring along the Sunda-Andaman Subduction zone due to northeastward motion

of the Indian and Australian plates relative to the Sunda plate caused associated Post seismic deformation in stress fields. In order to ascertain this deformation and the underlying dynamics we determine the state of seismotectonic stress of the region, bounded by -2°N to 16°N latitude and 89°E to 100°E longitude, from stress tensor inversion of double couple focal mechanism solutions distributed in nine different subsectors before (no. of earthquakes: 276; duration: January 1977-December 2004 & Mw (av.):5.5) and after (no. of earthquakes: 1020; duration: April 2004- February 2011 & Mw (av.):5.2) the 26th December 2004 mega thrust earthquake event. Stress inversion of focal mechanism solutions along nine subsectors (I-IX) reveals a relatively complex stress pattern. The Andaman-Sumatra-Sunda subducting lithosphere experiences nearly NNE trend. The average orientation of stress remains incomparable in both before and after the mega event, having been induced by the mega event. Compressive stress orientation before the mega event in nine sub-sectors had gone through significant change in orientation after the event. The result suggests that the stresses rotated due to co-seismic activity and post-seismic deformation. Dominance of thrust faulting in subsectors I, II and III indicates the orientation of compressive axis along NE-SW direction. The stress states reveal a NE-SW trending compression that affects all the broad sectors and subsectors creating E-W trending compression in southern part of the rupture. We then compare the sector wise reconstructed stress regime with the available information about geodetically determined displacement. Depth vs. Dip angle relation indicates successive increase in the depth of flexing of subducting slab along the subsectors. It is revalidated that NE-SW shortening refers to arc-parallel shortening in the slab which is normal to the trench in the fore-arc. The aftershocks caused by the main shock changed the

stress distribution in the crust and subducting slab which came up as a regional stress change along rupture area.

13 Elastic Properties of Gold Under High Pressure

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Keywords: Elastic Properties, Au, High Pressure, Seismic wave velocity

The present study deals with the elastic properties of the gold (Au) using a thermo dynamical method for the pressure range (0-200GPa). The geologically important quantities: second order elastic constants (SOE), Young's modulus, bulk modulus and shear modulus. The computed values of elastic constants of gold (Au) are used to obtain the seismic wave velocity (V_p & V_s) and sound velocity (V_B) at different pressure. The results are obtained with the help of present theory are in good agreement with the others results. Therefore, the present results may be important in geophysical study of these solids in earth's lower mantle.

14 The Plate Boundary between Indian and Myanmar Determined by GPS

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Key words: GPS measurement, Plate deformation, Velocity, CMT.

The existing status on the geodynamic processes using the number of Global Positioning System (GPS) measurement campaign along Indo-Myanmar Arc region, conducted in six years (2004-2010), allow quantifying the present plate deformation of the region. The velocity estimates in ITRF2000 varying between 52-32 mm/year suggest that the eastern block moves faster than the western block. It becomes clearer in the velocity estimates with reference to Indian plate varying 16-22 mm/yr. The sites in the western block moves slower and show little movement and sites in the eastern block show significant S–SW motion. The change in velocity in eastern and western regions occurs at the boundary of locally known fault “Churachandpur Mao Thrust (CMT)”. It appears that the two blocks are demarcated by CMT and this fault dips towards east and marks the boundary between India and Myanmar plate.

15 Tectonic Setting and Structural Disposition of Archaean Schist Belt of Orissa, India

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Key Words : Archaean schist belt, Tectonic setting, Structure, Orissa

The archaean schist belt of north Orissa comprises of the litho assemblages including the Banded Iron Formation, Iron Ore and associated rocks. The North Orissa Iron Ore Craton (NOIOC) along with three BIFs surrounding it and the granite complex belong to the Archaean Schist Belt. The iron ore belts are intra-cratonic basins, which acted as depository site for the BIF, iron ore and associated rocks. The tectonic setting is correlated with the iron ore orogeny. The belt has undergone multiple phases of deformation including folds and faults.

16 Palaeomagnetic and rock magnetic investigations on the intrusives of Singhbhum Craton

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Palaeomagnetic and rock magnetic investigations have been carried out on 60 oriented block samples belonging to 9 dolerite

dikes situated at Haludpukar and Onlajorito regions (south of Jamshedpur town), Singhbhum Craton. In the laboratory, 250 standard sized specimens were prepared from 60 collected samples. Natural remanent magnetization directions along with magnetic susceptibility have been recorded on all the specimens. The mean magnetic susceptibility and the mean NRM intensity for the collected rock samples were found as 1275×10^{-5} SI units and 9.59×10^{-1} A/m respectively indicating the strong magnetite component in the samples. To check the directional stability and to isolate the characteristic remanent magnetization (ChRM) directions AF and thermal demagnetizations were applied on 160 specimens. From the AF and thermal demagnetization spectra, it was observed that the secondary component was cleaned by the application of 150 Oe AF field or at 350°C thermal step yielding the primary directions in the AF fields 200-450 Oe and 400°C-550°C thermal steps. Based on the yielded ChRM directions, dolerite dykes ages were assigned as 2200 Ma. Rock magnetic investigations comprising of isothermal remanent magnetizations curves and high temperature susceptibilities indicated magnetite as the major magnetic mineral in the studied samples.

17 Active tectonics for inclusive geo-hazard management for sustainable development: case study from Kali River Valley, Kumaun Himalaya, India

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Key words: Active tectonics, geo-hazard, geomorphic indices, Kumaun Himalaya

Assessment of active tectonics is critical to many developmental activities, so that hazards be mitigated and structures can be sited in ways that serve their functions most effectively. In order to fully evaluate ongoing tectonic activity and related hazards requires knowledge of the rates, styles, and patterns of tectonic processes. With a view to mitigate geo-hazards, special attention to ongoing tectonic activity, its rates, styles, and patterns is a prerequisite. The ongoing patterns of tectonic activity leading to some catastrophic events are difficult to delineate by a few-year data base or even by all of recorded history however; geomorphic indices may used as useful tools in evaluating active tectonics as they quickly provide insight concerning specific areas or sites in a region that is adjusting to relatively rapid rates of active-tectonic deformation.

The paper deals with studies of geological hazards *viz.* earthquakes, landslides, river erosion etc in sub-basins of Kali River basin in Kumaun Himalaya in relation to zones of active tectonic deformation. The terrain expresses the conspicuous physiographic setting with nearly east-west trending linear ridges geomorphic with topographical features showing prominent relief. Geologically, area is occupied by the Almora Group and Garhwal Group of rocks. The

rocks of Almora group generally comprises of phyllites, schists, gneisses and slates while that of Garhwal Group is an assemblage of interbedded quartzite, phyllite, shale and limestone/dolomites. North Almora Thrust (NAT) passes through the central part of the study area.

The earthquake hazards have ravaged different parts of the area and are attributed to various tectonic features in the area and its environs. Amongst the largest was 28 August 1916 event of estimated magnitude of 7.5 on Richter scale that caused heavy damage to civil structures in Dharchula (GSI, 2000). The Kapkote earthquake (M=6.0) of 28 December 1950 resulted in collapse of houses and generation ground fissures. The Dharchula earthquake of 29th July 1980 (M=6.1, Max MMI=VII) and Indo- Nepal earthquake of 5th Jan 1997 (M=5.5, Max MSKI=VII) have been studied by the Geological Survey of India (GSI 2000). The effects of Uttarkashi earthquake of 20th October 1991 which took a toll of 768 human lives besides inducing numerous rock slides, ground fissures and changes in hot spring chemistry, have been recorded in the area. The seismic records reveal that the area is dominated by shallow forms (0-40km) earthquake events.

Records of all landslide hazards and areas of severe bank erosion in the area have been identified during field checks and from study of satellite geo-coded imagery of 1997 and 1998 period. Out of total 72 landslides recorded in the area, failures in most of them involve unconsolidated Quaternary deposits. The analysis of failure of slope indicate that majority of landslides (44%) are in the Quaternary sediments formed by various processes.

Geomorphic parameters are indicative to the influence of tectonic deformations in any drainage basin; accordingly morphometric indices such as Asymmetric Factor (AF) and

Transverse Topographic Symmetry (T) of different sub basins have been analyzed to delineate potential active tectonic zones. Block tilting of catchments of the Kali river basins *vis-a-vis* the North Almora Thrust show block tilting across this tectonic plane. The vector magnitude of tilt, north of NAT has been deciphered to be in SE direction (N135°) and that on south showing WNW to NW tilt direction (mean vector direction being N314°) indicating reverse tilting or torque motion tectonics (Agarwal and Sharma,2011).

The impact of tectonics manifest in the form of drainage migration, thus, provide clue of nature of oblique tilting along the thrust plane. The study has helped in understanding Quaternary tilting which may be attributed to manifestation of ongoing deformation. A Landslide scatters shows that the location of various landslides well corresponds to the delineated active tectonic zones in Quaternary sediment zones showing tilting of blocks. The inclusive analyses of records of all the geological hazards such as earthquakes, landslides and bank erosion and associated blocks of active tectonic deformations are crucial for the developmental planning in the area.

Agarwal,K.K. and Sharma,V.K. 2011. Quaternary tilt-block tectonics in parts of astern Kumaun Himalaya, India, *Zeitschrift fur Geomorphologie*, Stuttgart, Germany Vol.55/2, June 2011, pp. 209-229

EARTH RESOURCES

18 Integrated Exploration of “Calcrete Type Uranium” in Indian Desert using High Resolution Ground Penetrating Radar.

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Key Words: Calcrete type uranium deposit, Carnotite, Malani Igneous Suite, Ground Penetrating Radar

Exploration of the non-conventional uranium deposit expected to present as mineral Carnotite $[K(UO_2)(VO_4)_2 \cdot 3H_2O]$ in non-pedogenic calcrete of the Indian desert have been initiated for the first time. Regional hydro-geochemical survey has helped to demarcate small target areas showing unusual high concentration of uranium locally in the groundwater. Uranium deposits are likely to be formed in calcrete of a region where deeply weathered, uranium rich granites occur in semi-arid climate. Provenance rocks of the Malani Igneous Suite (MIS), namely granites and rhyolites, at south of Jodhpur city have been explored. Petrological and geochemical studies showing that high uranium and high potash is present in these rocks, while mafic components have contributed vanadium. The slow moving and upwelling groundwater rich in leached uranium undergo changes allowing carnotite to get precipitate near surface yet below calcrete. The changes in groundwater includes sorption, uranyl complex dissociation, changes in redox state of constituent metals, evaporation, variation in CO_2 partial pressure, pH, mixing of groundwater and colloidal precipitation. Yet another

positive feature of the terrain is that there are low order palaeochannels of river Lunavati, presently called Luni- a tributary of the lost Vedic river Saraswati. In the catchment areas of potential provenance, palaeochannels have been accurately drawn. High resolution (400 MHZ) Ground Penetrating Radar has been used at selective potential sites of such palaeochannels to detect presence and thickness of non-pedogenic calcrete. “Terra-search” equipment has been used and data have been interpreted using “Radon” software. Potential sites have been proposed for the drilling with hope of high degree of success for the better energy resource discovery and service to the human prosperity of the society.

19 Status of Iron ore resources development in context of Investment in Steel sector in India with special references to Odisha state, threats ,opportunities & roadmap

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The abundant resources for in Orissa state is ideal for massive investment in Steel sector . The state has abundant resources of Iron ore, Manganese ore, Bauxite, Limestone, Dolomite, Chromites, Coal, Gemstones and Decorative Stones (Granites). Based on the large resources of Metallurgical grade Iron ore and bauxite, it has been planned to set up a number of iron and steel plants, aluminum complexes, Power plants.

With >5000 MT of iron ore reserves, with a host of accompanying advantages Orissa has substantial reserves of other minerals, which go into steel making, like coal – 61,999 MT (24.37 per cent of the national deposit), dolomite – 1734 MT, limestone – 1737 MT & Mn-152 MT. Other mineral deposits are: Chromites---- 209 MT, Bauxites---1808 MT.

We can not think of Iron ore without touching Steel. STEEL is universal intermediate in building up materials base of economy, especially for industrialization & construction of physical infrastructure. Target of Steel consumption of 70 MT BY 2012 AD & 150 MT by 2020, principally through domestic steel product.

20 Ore Atlas – An useful document in mineral processing and utilisation.

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With rapid progress in science, there are many data bases. This has helped to prepare atlas in respective scientific disciplines like palaeontology, medical science, glaciers, kimberlites and psychology etc. Till now there is no atlas in the area of ores and minerals. India, being rich in oxide minerals, this author having characterized so many oxide minerals of India, has therefore made an attempt to prepare a similar document under the title “Atlas of Oxide Ores of India and their Textures”. This covers bauxite, chromite, ores of iron, manganese, tin, tungsten and rutherfordium including placers. All throughout the text, intergrowth patterns have been highlighted, with a brief note on their occurrence, reserve, production and consumption scenario etc.

21 Mineralization in the Uttaranchal Himalaya with specific reference to some possible sites for mining of polymetallic sulphides in future

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Keywords: Mineralization, Polymetallic sulphides, Himalaya, mining, Uttarakhand

The studies on the mineralization in the last 160 years by a number of Government and other Organisations indicated that there are widespread occurrences of polymetallic and non-metallic minerals in the different lithotectonic units of the Uttaranchal Himalayan Domain. But due to socio-economic, political and rough terrain, some parts of the present Uttarakhand State, particularly the territory of erstwhile Tehri State - which includes the present Districts of Tehri Garhwal, Uttarkashi and parts of Rudraprayag, Chamoli and Dehradun Districts, received less attention in the past for its mineral resources, as compared to other parts of Uttarakhand - particularly the British Garhwal (Pauri) and Kumaun region in the Indian Union. The lack of comprehensive data on mineral resources of the Uttarakhand State, is a handicap for the Planners of this State. Based on his studies of the last 38 years, the author attempts to highlight the mineral potential in the Uttaranchal Himalaya vis-à-vis their exploitation in future for better development of this newly created Hill State. There are several workable polymetallic sulphide deposits in the Uttaranchal Himalaya i.e. between the River Yamuna in the west (Himachal Border) and River Sharda in the east (Nepal Border). In this region, the polymetallic sulphides of Cu-Pb-Zn-Fe (rarely of As & Sb) are distributed in a variety of Precambrian

lithotectonic domains. The polymetallic sulphide mineralizations in this region occur in the Precambrian Inner and Outer Carbonate Belts of the Lesser Himalaya, in the sedimentary volcano-clastic sequences, in metamorphics (quartzites, talcose schists, chlorite schists, gneisses, metabasics and metagranites) and with the magmatic rocks occurring as Thrust Sheets over the Lesser Himalayan sedimentaries. The Precambrian polymetallic sulphide mineralization in the region had witnessed the later Tertiary Himalayan Orogeny, which had obliterated the earlier syngenetic and synsedimentary imprints in them (the stratabound and stratiform nature are affected by the deformation, metamorphism and magmatism) However, the primary depositional and other features are scantily seen in the field on which the secondary remobilization features have developed (quite conspicuous in thin sections as well as in the field). The secondary remobilized polymetallic sulphides are generally of veins, cavity, voids, lenticles and fracture filling types. The primary syngenetic types mainly occur in the bedded form and as streaks, besides as specks and disseminations in the rocks (particularly in younger dolerites and massive metabasics). At many places the synsedimentary mineralizations show folded and metamorphosed nature. The magmatism provided the necessary fluids to carry the metal cations to the suitable sites of deposition in the vicinity deformed rocks-away from the acidic magmatic bodies. The present study on the sulphide mineralizations in Uttarakhand State clearly shows that both the syngenetic and epigenetic features as well as the imprints of the Himalayan Tectonics are present in these mineralizations. Further, the studies on some old workings/ abandoned mines in the Uttaranchal Himalaya and the wide distribution of the sulphides in a variety of rocks ranging in age suggest that: There are many localities in the Uttarakhand State (like Nagnath-Pokhari, Gauchar-Mohankhal-Dhanpur, Dhanpur-Pokhari, Thalishain-Marora- Baijro-

Bungidhar, Tambakhani-Tiuni in Uttarkashi, Tons Valley, Jaurshi, Askot, Sisakhani, Galpakot-Kimkhet, Khansue-Rithanth and in Pithoragarh), are some of the prospective candidates for mining for Pb, Zn, Cu, besides Au, Ag, As and Sb as byproducts.

22 Geological Characterization and Genetic Modeling of Fluorite Deposit at Karada in Neoproterozoic Malani Igneous Suite, India.

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Key words: Fluorite Mineralization, Hydrothermal Intrusive Breccia, Hydrothermal Collapse Breccia, Karada, Malani Igneous Suite

The Karada fluorite deposit is situated (Latitude $72^{\circ} 14' N$ and Longitude $25^{\circ} 15' E$) about 25 kilometer northwest from Raniwara, on Raniwara-Sanchor road and is part of Bhinmal tehsil, Jalore district, Rajasthan. India. Bimodal volcanics of the Malani Igneous Suite (Neoproterozoic) at Karada is consisting of two mafic units and one felsic unit . The felsic unit is sandwiched between lower mafic unit I and upper mafic unit II. Lower mafic unit consist of mafic components of sub volcanic to volcanic nature and are of andesitic to trachytic composition. Middle felsic unit is of porphyric rhyolite which is further overlained by basaltic trachytic mafic components of mafic unit II. Volcanic breccia with fluorite is the youngest among the host rocks. The main mineralization are confined in volcanic breccia with orientation of all the veins in $N 43^{\circ} E-S 43^{\circ} W$ direction with subvertical dip towards west. In both the mines (Rekha and Santoshi), Fluorite is well filled in interspace available between the fragments of acidic and mafic volcanic rock apart from low grade fluorite fragments finally constituting the volcanic breccia. Detailed geochemical and petrological studies favour that the host rock magma must have originated deep inside of the earth. Crustal assimilation and fractional crystallization are the proposed mechanisms. The genetic model show a disruptive

intrusion by a turbulent fluidized system which was the dominant process, initially. The intrusive aspects of fluorite breccia show angular killas fragments encompassing a wide range of sizes all cemented by microcrystalline fluorite itself. This is followed by two episodes of collapse, a major and a minor; resulting in enclosure of early-formed fluorite fragments into later-formed fluorite matrix. These episodes were followed by pervasive silicification and metasomatic alterations. A thirteenth stage genetic model is hence proposed for the fluorite ore body, which combines the features of both intrusive breccia and collapse breccia type hydrothermal deposit of volcanogenic origin.

23 Discovery of a PGE deposit near Bangur, Kendujhar District, Orissa.

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Keywords: PGE mineralization, Singhbhum craton, mafic-ultramafic suite, breccia zone.

A hitherto unknown PGE deposit is reported from Bangur, Kendujhar district, Orissa in the southeastern margin of Singhbhum craton. PGE mineralization of substantial grade and extent is noted in a prominent breccia zone occurring within mafic-ultramafic suite of rocks. The mineralized breccia zone extends for about 550m in NW-SE direction with a mean width of 12m. Chemical analysis of drill core, bed rock and channel samples by ICP-MS indicates an average PGE content of 3.89 ppm. Occurrence of discrete grains of PGM in sizes up to 45 microns is confirmed by SEM-EDX and EPMA study.

24 Mineral Potential Zone identification using Remote Sensing techniques, A case study of SE Rajasthan

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Key words- GIS, GPS, Landsat TM, ETM+, Lineament, PCA, Remote Sensing

Rajasthan state is especially rich in mineral deposits. Integration of available background information in Geographic Information System environment leads to develop Mineral Exploration. Landsat TM and ETM+ were used to classify the various geologic, geomorphologic and structural features, discriminate the lithology and delineate the associated zones for mineral deposit. A wide variety of digital image processing techniques were applied such as the Principal Components analysis. The color composite of PC enabled us to determine the different types of sedimentary rocks in the study area. The selective PCA of ETM+ using bands 1, 3, 4, and 5 was used for mapping of iron and iron oxide bearing minerals. GIS can describe and analyze interactions, to make predictions with models, and to provide support for decision-makers. Steps of mineral potential zone mapping includes identify mineralization recognition criteria, data preparation and structuring, producing factor maps and combining of factor maps in the appropriate inference networks. In this research, conventional models for combining factor maps have been investigated and GIS model were selected for mineral potential zone mapping.

25 Study on Chromitite within Easter Ghats Around Asurabanda-Moulabhanj Area, Dhenkanal Dist, Orissa, India

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Key words : Chromitite, mafic-ultramafic, Eastern Ghats, Orissa

The chromitite in association with mafic-ultramafic rocks occurs around Asuraband-Moulabhanj in Dhenkanal district of Orissa. The ore bearing complex are emplaced into genesis and granulite of Eastern Ghats lying within the shear zone. The zone constitutes the contact between two tectono-metamorphic terrains running in east-west direction. The chromitites bodies are subvertical and consist of spotted band, schlieren band, massive band, narrow stringers and nodular in character showing cumulus, clot, net and cataclastic texture. The chromitites bodies are fragmented and deformed. Ore petrography indicates that the chromitite bodies are formed by a combination of processes such as crystallization, deformation and alteration.

26 Bio-mining from metal contaminated sites

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Key words: Bio-mining, Bio-harvesting, phytomining, bio-ore

Bio-mining is the Bio-harvesting of metals from high biomass crops grown in soil substrates, particularly those associated with sub-economic mineralization is termed bio-mining or phytomining. Biomining has application as an alternative to more

traditional physical-chemical methods of mineral processing. Commercial practices of biomining are usually partitioned into two separate processes: minerals bio-oxidation and bioleaching. It is a recent more advanced technology of phytoremediation to produce low volume, sulphide-free 'bio-ore', which can either be safely disposed of or, if the target metal is of sufficient economic value, smelted, and recovered. This technology has potential application in the mineral industry to return an economic profit by commercial production of metals via cropping.

PETROLOGY AND PETROCHEMISTRY

27 Petrogenesis of the Archean TTG gneissic basement rocks of the Bundelkhand Craton of the Central India.

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The continental crust holds the key to the record of how processes of crust generation have evolved through geologic time. One way of deciphering the primitive crustal composition and its evolution through time is to study the petrographic and geochemical attributes of the various rock types preserved in Archean terrains.

In the present study we have carried out petrochemical characterization of the Archean TTG gneisses of the Bundelkhand Craton of Central India. Our findings show that these rocks formed at shallow levels from a calc-alkaline magma with high potassium content by partial melting of plagioclase poor to plagioclase rich source in a syn-collisional regime.

28 Geochemistry of Pegmatites from Narnaul area of Delhi Supergroup rocks, Haryana State, northern Peninsular India

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Keywords: Geology, Geochemistry, Pegmatite, Narnaul, Haryana.

Metasedimentary rocks of Delhi Supergroup (900-1600 Ma; latitude 28°2' - 28°7'N and longitude 76°3' - 76°7'E) are exposed in the Aravalli mountain (S of Haryana State). This area consists quartzite, schist, granitic gneiss, basic rocks, calc rocks, phyllite, slate, granite, pegmatite and veins of quartz. Most of the pegmatites of the study area intruded into the quartzite. Pegmatites occur as irregular masses, dyke swarms, branching dykes, criss-cross veins and elongated lenses. They strike NNE with low dip angle. Dimensions are variable (0.5 m - 250 m length and 0.5 - 100 m width). Narnaul pegmatites consist of quartz (smoky, milky, yellowish brown, buff), orthoclase, albite, biotite, muscovite, tourmaline, calcite, beryl, garnet, hornblende and natrolite in the decreasing order of abundance.

Pegmatites show (in wt %) SiO₂ (73.6 – 76.81), Al₂O₃ (13.09 – 16.92), Na₂O (2.6 – 3.48), K₂O (0.75 – 3.71), Fe₂O₃ (1.57 – 6.21), TiO₂ (0.01 – 0.05), CaO (0.15 – 1.41), MnO (0.02 – 0.08), MgO (0.01 – 0.08) and P₂O₅ (0.01-0.09). DI ranges from 79.9 to 90.6 and AI ranges from 0.38 to 0.56. In the CIPW normative minerals composition, quartz and orthoclase vary from 45.70 to 56.04 (Avg. 48.79) and 5.08 to 21.92 (Avg. 12.96) respectively. Albite ranges from 22.0 to 29.45 (Avg. 25.44). An/(An+Ab. 0.09). Density and viscosity ranges from 2.71 – 2.84 and from 1.19 – 1.35 respectively.

They lie in the field of peraluminous granites in the Maniar & Piccoli diagram. In the tectonic discrimination $R_1 - R_2$ diagram they plot in postorogenic tectonic settings. In the K_2O vs Na_2O diagram their I types depicted. Thus the geochemical data show that they are I-Type, peraluminous and postorogenic characters.

29 Trace Element Geochemistry and Tectonic Setting of Mafic Metavolcanics of Baghmara Formation, Sonakhan Greenstone Belt, Central India

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Key Words: Geochemistry, mafic metavolcanics, Baghmara Formaion, Sonakhan Greenstone Belt, tectonic setting.

The Sonakhan Greenstone Belt (SGB) is a late Archaean Greenstone Belt covering an area of about 1200 Sq. km. along the Northeastern part of Raipur district of Chhattisgarh state. It comprises metavolcanic and metasedimentary sequences which have undergone greenschist to amphibolite facies of metamorphism. The supracrustals around Sonakhan and adjoining area are classified into relatively older Baghmara Formation dominated by mafic metavolcanics and felsic metavolcanics and a younger Arjuni Formation dominated by sandstone and polymictic conglomerate, the later includes clasts derived from Baghmara Formation. The two formations together constitute the Sonakhan Group.

This paper presents an account of trace element geochemistry of mafic metavolcanics of Baghmara formation, a prominent component of Sonakhan Greenstone Belt(Central India). The utilization of geochemical data as geochemical tool to recognize

the tectonic setting of the Baghmara Formation through (i) the use of tectonomagmatic discrimination diagrams (ii) the use of inter-element ratios of study area and their comparison with those from areas of known tectonic settings. (iii) the use of spider diagram and (iv) through geochemical screening, indicated an over all Island Arc tectonic setting for the mafic metavolcanics of Baghmara Formation.

The convergent tectonic setting deciphered by the geochemistry of mafic metavolcanics of Baghmara Formation could possibly be related to the collisional tectonics of Bundelkhand Craton and Bastar Craton. Therefore, the evolution of Sonakhan Greenstone Belt could be attributed to the response of subduction of for the subduction of Bundelkhand Craton underneath Bastar Craton along CISZ as suggested by the initiation of subduction along CISZ at around 2700 Ma.

30 Geochemical Investigation of the Ghordewa Coal Seams, Korba Coalfield, Chhattisgarh.

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The geochemical investigation of the study area lies entirely within the Chhattisgarh basin and is a part of Korba Coalfield. The coal bearing beds of these studied area from “Lower Barakar” of Permian age of the Lower Gondwana formation. The coal seam are underlain and overlain by coarse to medium grained sandstone and black carbonaceous shale. Seam G – I is the lower and Seam G – III is at the top of the section. The coal samples of G – I and G – III seam have been collected from Balgi, Surakachhar and Banki colliery, Korba Coalfield Chhattisgarh, have been studied to ascertain their basic chemical variation and physical properties in order that the information gained might be applied to future studies of Indian coals.

The investigation reveal that the coals of these colliery is of drifted in nature and falls under the category of C and D of Indian coal grading classification (1975).

WATER RESOURCES

31 Consequences of Climate Change and Adaptability in Water Sector- An Overview with special reference to Western India

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Climate change and its adverse impact are being felt all over the globe and is being looked upon as a major challenge to sustainable development . The impact on water sector is likely be more and more pronounced with highly uncertain precipitation causing enhanced drought and flooding with different trend. India is also likely to be impacted severely by the changing climate. Though per capita emissions are comparatively low, India remains the fourth largest emitter of Green House Gases in the world, contributing over 5 percent of global emissions. .

With 2.4 percent of world's land area, India supports 18 percent of the world population. India's biocapacity potential represents its greatest asset and sustainable agriculture is a key concern for India . India's water footprint depicts moderate to severe stress on blue water resources and water is not only critical for agricultural development but a large amount of fresh water withdrawals results from industrial processes, and coal and nuclear based power generation processes. India,s economy is highly dependent on well being of its agriculture sector. The

sustainability of the agriculture sector is dependent upon the availability of water at proper time and in adequate quantity . it is very rightly said that water security is food security. The paper written with an objective for wider communication and awareness creation , examines the impact of climate change and its variability on water sector and highlights the adaptability measures to withstand the consequences of changing climate scenario vis a vis water availability citing feasible and existing practices from western India to ensure the effective adaptation. The input provided by this paper may help in development of sound policy towards adaptation with the consequences of climate change in water sector which may be replicated in similar agroclimatic region.

32 Groundwater resources and its quality in the drought-prone western parts of Orissa

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Key words: Eastern Ghats, Acidic nature, Hard water, Corrosive, Incrustative

The area of study occupies the drought-prone western parts of Orissa in the districts of Balangir, Sonepur and parts of Bargarh covering an area of about 12000 sq. km. in Survey of India Toposheet numbers 64K, 64L, 64O, 64P, 73C and 73D. In the area, rocks belonging to Precambrians such as Eastern Ghats Group, Chandarpur Group, granitoids and anorthosites are exposed in addition to rocks belonging to Gondwanas, laterites and alluvium. Nearly ninety percent of the area is underlain by consolidated formations followed by semiconsolidated formations of Gondwana age and unconsolidated formations of recent age. The level of groundwater development is quite low varying from 18.40% in Sonepur district to 21.02% in Balangir and 21.93% in Bargarh

district. Analysis of 231 groundwater samples from both shallow and deeper aquifers each in the pre-monsoon and post-monsoon seasons indicate wide variation in the concentration of the chemical constituents which is due to the differences in the chemical composition of the aquifers and their hydrologic properties. The pH of almost half of the samples indicate their acidic nature and in some cases the values are even below the maximum permissible limit. Groundwater in many cases is hard to very hard. Chloride and nitrate in some urban water samples are quite high which are due to sewage contamination. The fluoride, iron, cadmium and chromium in some of the samples are higher than the potable limit for drinking and the people of the concerned localities should be warned. With respect to irrigation, more than half of the samples are of high salinity class which requires proper plantation. Magnesium hazard is noticed in almost half of the samples. With respect to potential salinity, almost one fifth of the samples are injurious to crops and need attention of the planners.

With respect to industrial use, many water samples are corrosive and incrustative requiring pre-assessment of their quality before their use in industries. Comparison of the water quality of the pre-monsoon and post-monsoon indicates enrichment of the chemical constituents in pre-monsoon and their subsequent dilution in post-monsoon due to recharge of the aquifers from rain water.

33 Accessing the impact of land use change on the hydrological regime of the Tawi Catchment

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Land cover changes may have immediate and long-lasting impacts on terrestrial hydrology, which alter the long term balance between rainfall and evapo transpiration and the resultant runoff. In the short-term, destructive land use change may affect the

hydrological cycle either through increasing the water yield or through diminishing, or even eliminating, the low flow in some circumstances. Various hydrological processes such as interception, infiltration, evapo transpiration, soil moisture, runoff and ground water recharge are influenced by land use/ land cover characteristics of the catchment. This study is mainly focused on the assessment of the hydrological response of the Tawi catchment in relation to the land cover data of 2000, 2008 and 2016 using a Geographic information system (GIS) by integrated with the hydrologic modeling. In the tawi catchment the change has come about mainly due to deforestation in around the major cities Jammu, Udhampur, Katra area and as these areas forest land is converted into expanded urban land and agriculture land. The effects of land cover changes have an impact on the water balance of the catchment by changing the magnitude and pattern of runoff, peak flow and ground water level. This work has been done in the study area by the integration of the two models; CA (Cellular Automata) and SWAT (Soil and Water Assessment Tool). The Cellular automata model has been used to determine the land use change dynamics between the year 1992, 2000 and 2008 based on which, the future land use scenario for the year 2016 has been generated and consequently SWAT (Soil and Water Assessment Tool) model has been used for determining the hydrological parameters for the corresponding year 2000, 2008 and 2016. In present study , the Metrological Data has been used as an input parameter for running the Hydrological model SWAT(Soil and Water Assessment Tool), which include the parameter like Maximum and Minimum Temperature in degree Celsius, Precipitation(mm), Wind Speed ($MJ/m^2/day$), Sunshine duration ($MJ/m^2/day$), Relative Humidity (%) and Dew point temperature ($^{\circ}C$) on daily basis. For assessing the future impact of landuse change on the Hydrological regime, We have to used the future climate data such as Maximum and Minimum Temperature and

Precipitation. We have used General Circulation Model (GCM) and Statistical Downscaling Model, HadCM3 model having Grid size 2.5×3.75 and A2, B2 scenario is used for downscaling for predicting the future climate data of the year 2016. In the present study, the Remote sensing data is helpful for assessment on the land cover change of the tawi catchment that Forest land would be decreased by 3.16% during the period 2000-2016 and this was mainly due to the expansion of agriculture area by 2.89% and also urbanization increased by 0.23%. Based on these results, the different hydrological parameters like Surface Runoff, Evapo transpiration, Infiltration were analyzed statistically to evaluate the changes in the land cover affected the hydrological response of the catchment. The results of the analysis indicate that the total water yield of the river Tawi was 2064.06 mm for the year 2000, whereas in scenario year 2016 the total water yield will predicted to be 2526.75mm. So because of the land cover change the flow will increase by 462.68 mm.

34 Potential Radiation Hazards due to Radon Concentration in Groundwater of Shillong Agglomerate

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Keywords: Radon, Groundwater, Annual Mean Effective dose, Inhalation, Ingestion.

The groundwater has been widely used for drinking and other household purposes and is the primary source of water for domestic requirements in Shillong. The radon is an inert gas formed

by the natural radioactive decay of Uranium in rock and soil. The radon (^{222}Rn) emanates through the litho types and moves along the porous and permeable zones after its recoil. Radon atoms entering the pore space are transported by diffusion and advection through the underground geological strata into subsurface aquifers and gets dissolved in ground water and move with it, until they decay or are released on decompression of groundwater. Groundwater has been found to have higher concentration of Radon compared to surface waters. Radon being carcinogenic, its occurrence in high concentration in water used for domestic purpose can pose a potential health hazard through inhalation and ingestion exposure. However, ingested and inhaled radon is known to be promptly removed from the body by exhalation. Ingested radon is removed from the body through exhalation within an hour, while the longer-lived decay products are eliminated by urinary and fecal excretion. The extent to which radon is absorbed from the gastrointestinal tract and retained in the body depends upon its solubility in blood and in the tissues. Body adipose tissue is considered as the major site of long-term retention. Inhalation exposure directly affects the bronchial epithelium. Inhalation exposure of radon progeny arising from the release of radon to the indoor environment from domestic water use is considered more significant than the exposure due to direct ingestion of radon contaminated water.

In the present study, we have measured the radon levels in water from 19 groundwater sources situated in the Shillong agglomerate and subsequently calculated the Annual Mean Effective dose due to ingestion and inhalation of radon from the groundwater as per UNSCEAR (2000) model. The sampling is done on fortnightly basis for six months. The AlphaGUARD PQ 2000PRO operated at 1 minute flow mode is utilized for radon level measurements after background assessment. The measured radon

levels are found to vary from 8.60 to 39.55 Bq.l⁻¹. The measured concentration level in water is well below the proposed Alternative Maximum Contaminant Level (AMCL) viz. 148 Bq.l⁻¹ by U. S. Environmental Protection Agency (EPA). The Annual Mean Effective dose due to ingestion and inhalation are found to range from 1.50 - 7.42 $\mu\text{Sv.a}^{-1}$ and 18 - 89 $\mu\text{Sv.a}^{-1}$ respectively. The people of the region are advised to keep the water for some time or boil before using the groundwater for domestic purposes, especially, where higher radon levels are observed in the study area.

The measured radon levels vary with seismic activity in the region and its direct correlation is noticed and further work is being carried out in detail.

35 Water Pollution Studies in Talcher Area, Distt. Angul, Odisha, India

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Key words: Water, pollution, hydrochemistry, Talcher coalfield, Odisha

Talcher, famous for coal mining in Odisha, covers an area of 1850 sq.km. within 20° 37'-21° 10'N latitudes and 84°-85° 28'E longitudes. Fifty one water sample were collected from different locations and their hydrochemical properties were studied.

The results revealed that in many locations the water was found to be acidic. TDS varied from 96.64mg/l to 695.68mg/l in pre-monsoon period and 69.76 to 1304.96mg/l in post-monsoon period. TA varied from 40 to 600 mg/l in pre-monsoon period and 40

to 1080mg/l in post monsoon period. TH varied from 70 to 640mg/l in pre-monsoon, but 90 to 420mg/l in post-monsoon period. Ca ranged from 20 to 155mg/l and 15 to 280mg/l in pre and post-monsoon period respectively. Mg varied from 0.609 to 87.048mg/l in pre-monsoon and 0.609 to 48.170mg/l in post-monsoon; similarly, Na varied from 1.33 to 175.52mg/l and 8.32 to 332.43mg/l; k varied from 20.2 to 55.43 mg/l, 0.33 to 35.63mg/l; HCO₃ varied from 49.1 to 279.5mg/l and 48.8 to 292.8mg/l; SO₄ varied from 4.8 to 240.41mg/l and 1.40 to 215mg/l; Cl varied from 15 to 250mg/l and 35 to 395mg/l in pre and post-monsoon period respectively. Fluoride varied from 0.138mg/l to 1.45mg/l in pre-monsoon and 0.102 to 2.45mg/l in post monsoon period. Out of 51 samples, five samples showed higher concentration above permissible limit of 1.5mg/l.

Based on TDS value the water was found to be non-saline and fresh. As per the classification on the basis of TH, the water was found soft to very hard, N% indicated the water to be excellent to good, SAR indicated the water to be excellent. The data plotting on Piper's diagram revealed Ca-Mg-HCO₃ and Ca-Mg-Cl type of facies for pre-monsoon period and post-monsoon period respectively.

36 Application of Vertical Electrical Sounding (VES) Technique to Decipher Groundwater Potential Zones around Muddapur Village, Mudhol Taluk, Bagalkot District, Karnataka State

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Key words: VES, groundwater exploration, hard rock terrain, Muddapur

Vertical electrical soundings were carried out in 25 locations using Schlumberger electrode configuration with maximum current electrode separation (i.e. AB/2) of 150m around Muddapur village. The instrument used is IGIS Resistivity meter. The area comprises of dolomitic limestones of Kaladgi series of Proterozoic age. The occurrence of groundwater in hard rock terrain is mainly controlled by structure, landform, lithology and recharge conditions. The objective of the investigation was to understand sub-surface geological and hydrogeological conditions and to identify potential zones for groundwater exploration which in-turn is beneficial to farming community and industries. The VES curves obtained are of A, H, KH and KHKA type. The VES results reveal 3 to 4 layer sections. The soil thickness varies from 0.5 to 2m, weathered zone between 2 to 12m, jointed formation between 12 to 50m, jointed and fractured formation between 50 to 70m where water strikes and is the first water bearing zone and there is another highly fractured and jointed formation between 70 to 120m which is a second water bearing zone yielding good amount of water. After 120m a hard massive limestone devoid of fractures and joints is encountered. Out of 25 locations surveyed 10 locations have been recommended for drilling up to a depth of 130m. The results revealed that 7 bore wells

yielded 3000 to 3500 GPH where as 2 bore wells are poor yielding that is 500 to 1000 GPH and one is very poor yielding. The apparent resistivity values ranges from 15 Ohm-m to 1050 Ohm-m. The correlation of VES data and borehole log data for lithology matched well in most of the cases. In the investigated area deep bore wells are successful.

37 Groundwater quality with emphasis on its fluoride content – A study in Khoyrasole Block, Birbhum District, West Bengal

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Keywords: Groundwater, Water quality, Fluoride content, Correlation coefficient and Khoyrasole Block

Water is one of the most precious gift from nature, whose presence is absolutely vital for the sustenance of life. Man has been drawing on this unique natural resource from times immemorial. Over the years growing demand for water by the varied needs of human society have actually threatened its existence. As a complementary resource to surface water, groundwater is a valuable natural resource for drinking water. Like the other natural resources, it also demands systematic monitoring of its quality and the dwellers should be made aware of its quality. High fluoride concentrations are most often associated with ground waters as these accumulate fluoride from rock dissolution as well as geothermal sources. Many high fluoride groundwater provinces have been recognized in various parts of the world, particularly Northern China, India, Sri Lanka, Mexico, The Western United States, Argentina and many countries in Africa. High fluoride concentration in groundwater has been found in parts of Birbhum district, West Bengal. The Bureau of Indian Standards (BIS, 1991) recommends 1mg/l of fluoride concentration in drinking water as the desirable concentration and

1.5mg/l as the maximum permissible limit. The bulk of fluoride intake in human beings comes from drinking water and in small fraction through food stuffs and beverages. Many cases of osteo-fluorosis have been reported from the district till now.

The present study was carried out in Khoyrasole block of Birbhum district, West Bengal to delineate the water quality of the area. The fluoride concentrations in groundwater have also been determined, since it is the only source of drinking water. Various other water quality parameters of groundwater such as pH, Total Hardness, Total Dissolved Solids (TDS), Calcium (Ca), Magnesium (Mg), Iron (Fe), Chloride (Cl), Carbonate (CO₃) and Bi-carbonate (HCO₃) were determined. For the statistical analysis, values of mean, standard deviations and correlation co-efficient R were also calculated for these water quality parameters. All the parameters have been plotted against Fluoride to examine the relationship between each other. The results show that few samples [e.g. Anandanagar, Bataspur, Bhadulia, Bhaddi, Bheleni Chuagar, Hazaratpur and Uttar Putka] do not comply with Indian as well as WHO Standards. The fluoride concentrations in the groundwater of these villages varied from 1.52 to 4.75 mg/l, causing dental fluorosis among people especially in children of these mouzas. Overall water quality of the study area was found to be unsatisfactory for drinking purposes as iron and fluoride content exceed the allowable limit by a large margin.

38 Study of Groundwater condition in Tapin a coal mining zone of Hazaribagh district of Jharkhand state

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Keywords – Coalmining, Leachates , Gondwana.

Tapin is a coal mining zone of Hazribagh district. It produces prime coking coal this area is a region of plateau, residual hills and consist of crystalline metasediments and East-West trending lower gondwana coal sediments are the main rock type of the area. Groundwater mainly occur in cracks creavaces in metasediments rock type, fracture and weathered mantle form the main repository, groundwater occur in archeaan rock under confined condition.

When we analysed the groundwater of the area. The analytical results showed that pH is low and has got higher value in Hardness and TDS. As compared to drinking water standards of IS : 10500.

The increase in open cast mining activity has lowered the water table of the area. As we know that whole area is surrounded with open cast mine, coal washeries, coking coal plants and other coal based industries. It can be assessed that leachates from over burden dumps can percolate in the water regime of the area and can contaminate the groundwater. Regular monitoring of groundwater should be done regularly to know the exact situation of the concerned mining zone.

**39 Hydrogeochemistry of Keonjhar, Keonjhar District,
Orissa, India**

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Key words: Granitoids, Mg-Cl type water, Hard water, corrosive,
Incrustative

Chemical analysis of thirty groundwater samples in and around Keonjhar town, Keonjhar district of Orissa indicates acidic nature of the groundwater in most of the cases. Most of the groundwater samples are of Mg-Cl type. The groundwater with respect to pH, total dissolved solids, total hardness, magnesium, calcium in many localities have values beyond the highest desirable limit for drinking. With respect to chloride, sulphate, fluoride and nitrate only a few localities have higher values beyond the potable limit. The groundwater is fairly good for irrigation purpose. However, with respect to their use in industries, some samples are corrosive and some are incrustative indicating their unsuitability. The chemistry of the aquifer influences the chemical composition of groundwater.

**40 Analysis of drainage density and frequency: A case study
of Parbat Basin**

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Keywords- Landform, Density, Frequency, Tributary,
Geomorphology

Geomorphology is the science of landform and systematic

analysis of landscape is essential for understanding the nature, origin as well as for mutual relationship of any landform. As for as study of river basin is concerned the analysis of drainage density & frequency is one of the important aspects of the study. The nature of research problem being geomorphological the investigations were carried out on the topographical contour maps which are available on the scale 1 cm to 2.5 kilometers (R.F. 1:250,000), For drainage studies, drainage map has been also prepared by drainage density & frequency. Present study is based on Horton's (1945). That has been used by Horton's (1945) method.

MISCELLANEOUS

41 An Improvement in Method of Oil Spill Recovery

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Key Words : Oil spill, Conical Shaped Apparatus, Helical shaped pipe, Reynolds's number

The aim of this paper is to give an efficient, time saving, costless, mechanism which can be used along with the Conical Shaped Apparatus (a mechanical instrument used for recovery the oil spilled in Mexico) to recover an oil spill.

Our present study is based on how to get pure oil in minimum time from this Conical Apparatus. We have tried to get pure oil by achieving stream line flow with the help of helical shaped pipe along with this apparatus. This is done by analyzing the flow of oil in helical pipe considering always Reynolds's number (R) less than or equal to 2000. The study is carried out on different

combinations of Reynolds's number and different sized helical pipes to get pure oil in minimum time.

The model study of this mechanism is performed with different densities of oil considering thickness of oil, working temperatures and working conditions- static & wavy water. Thus we have found out the efficiency of this mechanism with respect to time and purity of separated oil up to 90%.

42 An Innovative Frame Work for Water Resource Management for Meeting the Future Energy Requirements

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The objective of the Water Resources Management Division is to administer various statutes as they relate to the allocation of water, stream alterations, protection of water supply areas, licensing of well drillers and other aspects of water resource management. Water Resources Management is the integrating concept for a number of water sub-sectors such as hydropower, water supply and sanitation, irrigation and drainage, and environment. An integrated water resources perspective ensures that social, economic, environmental and technical dimensions are taken into account in the management and development of water resources.

43 Health Care Practices among Tribal Population of Upper Narmada Basin, M.P. A Study in Health Care Geography

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Key words: Health care practices among tribal's

The concept of illness has always been personified to such a extent that its treatment is affected either by the use of mans hidden spiritual powers or by the application of plants that have been found to causation healing powers or both. The importance of traditional system of medicines are relating to geo-medical studies and the knowledge of conventional concepts of illness are paramount importance.

Health is the most precious gift of nature and its represents the balanced relationship between human body and adjacent environment and health care practices depends upon two things i.e. practice and medicine. In tribal areas due to less availability of allopathic medicine, people normally go for indigenious treatment which is locally and easily available.

Indigenious health care practices can be divided in two major groups:

1. Professional health care practices i.e. Ayurvedic, Homeopathic, Unani and Siddha system.
2. Non-professional folk health care practices: Jari-butti, Jadu Tona, Jhar-Phuk, Magic Mantra, Tantra etc.

As far as upper Narmada Basin in concern Mandla and Dindori are the major districts where most of the tribal populations are inhabited.

In each human society health and disease co-exist. The survival and contrivance of human society depends upon health and well being of its members. Since ancient times it has been the endeavor of the society to seek ways of eradication of illness and human suffering. Every society has developed a system to cope with disease according to its belief and values. Means each society has created a 'pharmacopoeia' and a therapeutic system be it magic, religious, secular or scientific

Folk treatment and Herbal Drugs are also widely accepted in Upper Narmada basin as well as the region has also very extensive reserves medicinal plants.

44 Impact of Mining Activities and Development on Ecological System (A Case Study of Jharkhand State)

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Minerals are important raw material for many industries and a major input in Industrial development. Mining is a fast growing industry all over the world and Jharkhand also. A large number of manufacturing and processing industries are dependent upon mining activities. Mining operation lead to widespread environmental destruction by way of deforestation and bio-diversity, erosion, earth cutting, soil erosion and overburden, hydrological disruption, solid and liquid waste and tailings.

The Jharkhand mining processes has promptly responded to the decline the eco-system. The population of Jharkhand depend upon forest and agriculture. Forest has day-by-day depleting due to mining activities. In Jharkhand mineral like coal and iron mostly found in forest areas. Forest and animals both are reside in forest in

a ecological balance. If one is extient both are orlient. This is a serious problem in Jharkhand.

Habitats of wild animal change in Jharkhand area. In recently the elephant of Jharkhand has depleted due to recent technology of mining exploration in coal mining area and iron ore mining areas, like Damodar basin region and Saranda forest region. These areas are worstly effected by ecological imbalances.

45 Impacts of Ports and Harbours on Coastal Geomorphology

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Key Words: Port and harbour, breakwater, erosion, beach profile, sediment, shoreline change

Ports and harbours involve construction of coastal structures such as groin, sea wall, break water, jetty etc. which result in modification of the shoreline and beach morphology. The contemporary phase of transformation of coastal geomorphology due to development of ports and harbours along the Orissa coast was examined through beach profile measurements, shore line mapping and grain size analysis of beach sediments using RTK GPS, DGPS ArcPad and automatic sieve shaker respectively. Beach width, volume of erosion and deposition and the shoreline change near Gopalpur, Paradeep and Dhamara port were estimated and their seasonal and interannual variability have been discussed.

46 Potential of Cartosat-2 Satellite data for generation of Land Resources Development Plan at Cadastral Level - A case study of Dhund sub-watershed (2D2A5a), Jaipur district, Rajasthan

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Due to increasing anthropogenic pressure on natural resources, it has been felt necessary that it would be worthwhile if a mechanism is developed for conservation, preservation and reclamation of land and water resources by generating action plan for land resources development at cadastral level. Increase in biomass and vegetation wealth in forested area would result in change in rainfall pattern of the region. It would further change the local climate of the region and help in arresting land degradation. In the present case study of Dhund sub-watershed (2D2A5a), Jaipur district, Rajasthan an attempt has been made to assess the potential of Cartosat-2 Satellite data for preparation of thematic maps and generation of action plans for land resources development at cadastral scale. The land resources action plan map generated at cadastral level would help in implementation of action plan at grass root level by local officials and villagers. These measures, if implemented with due care and proper attention would help in arresting the process of land degradation.

47 Role of Geomicrobiology in enhancing understanding of earth processes: Some solid examples

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The Earth's physical and biological processes continuously interact and influence one another, whereas we have academically classified the geological and biological sciences as separate entities. Both disciplines have grown and matured independently but lack of geobiological approach has led to poor understanding of the coupled earth-biosphere interactions. In this context, new cross-disciplinary courses in geobiology should be developed like in many parts of the western world. Some solid examples discussed regarding the role of geomicrobial knowledge in enhancing the understanding of geological processes are BIF, dolomite formation, rock weathering and cave formations.

48 Spatial pattern and determinants of HIV/AIDS in Madhya Pradesh : A study in Medical Geography

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KEY WORDS - HIV/AIDS Cruel Epidemic, Dispersion,
Awareness and Recapitulation

HIV/AIDS is a debilitating health hazard and a social reality rooted in human behaviour. It is particularly reported by high risk groups in urban areas, mainly among truck drivers, sex-workers, migrants and people engaged in hotel and tourist industry. Present

study is based on fieldwork and data plus information collected from Madhya Pradesh State AIDS Control Society, Bhopal. Though with respect to HIV/AIDS cases, the Madhya Pradesh state falls in a low priority zone in India but whole state is in cult of this syndrome. According to official sources 4580 AIDS patients are reported by October-2010 in the study area. As for as this health disorder is concerned, it is very sensitive and a lot of social stigmas are attached to it. Authentic information are not available at any level, but still author's have tried their best and concluded the alarming condition. To check this epidemic, awareness programmes and preventive intervention are urgent need of the day.

49 Variability in Precipitable Water Vapor – Atmospheric Residence Times

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Since the trend in annual/seasonal rainfall over India showed insignificant for the past 100 years, the authors of the present paper attempted to study the trends of precipitable water vapour which serves as the input for rainfall of that particular region. The study has been carried out using NCEP/NCAR reanalysis total column Precipitable Water Vapour (PWV) data of 2.5°x2.5° grid resolution during the period 1948 to 2010, and the results disclosed the decreased trend in All India PWV with a rate of 0.4% per year. The All India PWV showed a decrement/ increment of 2% / 0.2% during composite El Nino and La Nina respectively. The canonical correlation of Multi Variate ENSO Index (MVEI), Dynamical

Monsoon Index (DMI) and PWV, rainfall signified the impact of global teleconnections and proportionate variability during south west monsoon. Finally the paper dwells in obtaining the spatial variations of atmospheric residence times which are the inverse of the cycling rates of PWV. The results showed that the residence times varied from 2 to 5 days depending on the good/ bad monsoon year during to study period.

50 Innovative Earth Science for People's Prosperity Earthquake Prediction:

Challenges and Promises

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Key words: InSAR, 3-D visualization, IR Imaging, thermal anomalies, piezo-magnetic effect, precision GPS, satellite altimetry, advanced Earth models.

Man ever since it's evolution has wondered the cause of various natural phenomena such as thunderstorms, eclipses, earthquakes and various other phenomenon. Today we know the cause of some them and can even forecast their occurrences, thanks to the advancement in science and technology. But even till today there are several other phenomenon which we are not able to predict even with our most sophisticated equipment. Earthquake is one such phenomenon. Scientists and Engineers have been trying to develop a reliable system to predict earthquake for quite some time, but results have not been encouraging.

The recent advancement in Satellite technologies shows promising results in earthquake prediction. Methods such as Interferometric-Synthetic Aperture Radar(InSAR) and Infrared (IR)

Imaging can be used to predict earthquake days before it's actual occurrence so that people could be moved to safer places. Also GPS-based prediction system has been successfully tested by NASA to predict tsunami. Man has been striving hard to get a promising result in this field and make this planet a safer place to live in.

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VII

**ABSTRACTS OF
POSTER PRESENTATION**

**PROCEEDINGS
OF THE
NINETY NINTH SESSION OF THE
INDIAN SCIENCE CONGRESS**

BHUBANESWAR, 2012

PART II : (Abstracts)

SECTION OF EARTH SYSTEM SCIENCES

President : Prof. Pramod K. Verma

POSTER PRESENTATIONS

1. Four Innovate earthquake Indicators.

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Key Words : Transparent graph paper, Frequency, Enormous Magnet, Magnetic Lines, Reflection, Water waves. Bronge pipes, Microphones.

I invented four (tools) types of earthquake identification systems with the help of computers. These are all very simple to construct and very low expenditure. These four tools are as followed

- I) **Innovative seismograph:** It resembles (just) to well known seismograph. Water and polythene graph paper is main parts of this system.
- II) **Earthquake Information from magnetism:** In this System barmagant and colour coated iron powder are the impotent.
- III) **Earthquake identification from water waves:** According to water waves computer identifies.
- IV) **Earthquake Announcer:** This tool work is depended on bronge pipes, microphones, metal chips and computer.

2. **Geo-hydrological Approach of Watershed Development Programme in Angul Watershed, Orissa**

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Regional Cell-East, Bhubaneswar, Orissa,

Watershed development and management is consisting of various parameters which directly influence the daily life of local people. Watershed development program includes social development of the community in each and every aspect and simultaneously the natural resource management by considering ecological health. Land and water are the main influencing zone to restore and managing natural resources. To deal with various phenomenon of land and water, it is essential that a detailed study of ground water regime with respect to local and regional geology be carried out in the influence zones of the project area to know the behaviour of ground water and its relation to the soil and rock formation available in that area. The project area is located in Angul district in central Orissa. The terrain is undulating and several small streams and rivulets flow across the area eventually draining into the Mahanadi. The project area is underlain by different lithological units, which forms aquifers with heterogeneous hydrological and geo-hydrological characteristics. This will provide the necessary feedback information to plan out artificial recharge schemes. It would also guide us to select sites which would be the most favourable so that structure constructed will perform most efficient

with proper maintenance carried out after getting idea about recharge and discharge zone. In order to have result of implementation of the structures, a program of monitoring the progress will be designed using this understanding on Geo-hydrology.

3. Impact of assimilation of soil moisture and temperature data on simulation of pre-monsoon severe thunderstorm events over the Indian region

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and A. Routray³**

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In this study the impact of assimilation of offline soil moisture and temperature (SM&ST) simulated from land data assimilation system (LDAS) with Noah land surface model (LSM) on initiation and evolution of STS over the Indian monsoon region is explored. The results clearly show better performance of SM&ST data in the simulation of severe convection. CNTL shows warmer soils as well as boundary layer in the day time. While, the better representation of SM in LDAS improved latent heat flux gradients which appear to aid the development and evolution of deep planetary boundary layer. It could remarkably improve the PBL temperature and moisture and the wind improvement is marginal. Hence, LDAS could predict reflectivity echoes and associated rainfall bands efficiently. However, the CNTL could not simulate the convection because of lack of proper land surface data.

4. Geochemical studies on Sediments of River Mahanadi

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In the present investigation sediments of Mahanadi River have been studied to find out the types of minerals present in the river bed near Hirakud dam. The elements were analyzed with the help of Emission spectrograph. From the analysis results, the presence of SiO₂, Fe, Al, Ti, and Mn have been obtained, A comparative low percentage of Titanium indicates the presence of small amount of Ilmenite in the sample. A Values of 0.6 to 1.6% of Manganese have been found. Mn content is more in the coarser fraction and less in the finer fraction.

5. The Down Fall Of Aeronautics Flying Flights By The Devastative Grabimng Gravity

M. H. Ranebennur

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The flying flights Aeronautics Engines stepped in the era of Down Fall of Flying Machines. The team of investigators blames the Pilots faults, Mechanical Faults. Air Crew Faults, Ground Engineers Faults but they are not responsible for now a days Air Crashes, common Scenarios of heavy Rains and strong winds, misleads the iliac & hivesügating Team Black Box cannot record these Devastative fracters. Since the day of Tsunami our planets Internal Unrest begins, Earth & its living occupants are forced to face the man made calamity, Devastative Disasters are Reflections of our

Planet Earth's Internal Unrest, we have no Parameters to trace the real reasons of now a days Air Crashes, they are as under:

1. Earth's Fluctuating Magnetic power & earth's Reversing Magnetic Pull.
2. Fluctuating Earth's Gravitational Power and the Devastating Grabbing Gravity.
3. The Deep Inhaling & High Thirst of Violent Inner Core.
4. Intense Burning Behavior of Earth's Inner Core.

These Devastative factors enters in Flying Flights & Ignites, in flying flights Engine picks fire with smoke & dreaded sound, the plane blast with Thunderous Sound and explosions, the remaining pieces came down to Earth. Specially Air Crashes are common in Coastal areas as they are very precarious spots next Seas, Mountains, in the mid of busy High ways. In the Kitchens, in the houses, in thick populated area, on the Railway Tracks, even on Jogger's Head The Earth's Devastative Grabbing Gravity now reached into Zero Gravity, A Russian Space ship fail to reach the orbit, a supply spaceship carries 2.5 tons fuel, food, oxygen, & bounded for International Space station, the space cargo ship blast into pieces with the thunderous explosion, its pieces fallen in Saiberia jungle. In near future the International Space Station will be shut down permanently, and its Astronauts, Cosmonauts must bring back to earth to save them from starvation&deaths. Our Earth looses its grip on the moon, our moon started slides away 4 centimeters from the earth every year. Already our moon has started shrinking more than 100 meters in its size, and developed many cracks on its outer surface. Finally the moon will split into pieces in the end of days near Dooms Day. Since 150 years, our end of days started from the day when we have started oil spill technology. The constant exploration of Gas and Oil made the Earth sick, the oil Rigs

technology created the great grave gap under our feet. The inner cores extreme heat & deep breath, high thirst evaporate the underground water Tables & Reservoirs, Lakes, Rivers. The devastating grabbing gravity grabs mega structure celestial bodies, like Comets, Astroids, Meteoroids, resulting the decending of poisonous gas from sky and stoney rains, kills millions of people. Earth's Inner core become violent and savage, for its own survival, it starts deep inhaling creates trong winds, Tornadoes, heavy rains, floods, Mud floods, earth slides, Avalanche of mountains, Cities Sinking, frequent killer earth quakes, increasing volcanic eruptions in sea beds oceans boil with swell. Increasing Dc oxygenation zones in oceans kills under water creatures.

6 Application of Gutenberg-Richter power law to the 2001 Bhuj Aftershock Sequence

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Keywords: Power law, b-value, frequency-magnitude distribution, seismic hazards.

Gutenberg-Richter power law well expresses the frequency-magnitude distribution. The b-value of the frequency-magnitude distribution for the 2001 Bhuj aftershock sequence are investigated for more than 9000 aftershocks identified during the last decade after the 2001 Bhuj earthquake. We used IMD and ISR data catalog containing aftershocks with magnitude larger than or equal to 1.0. We calculate and map the b-value for different time interval from the main shock and for different spatial zone of the Kutch region. We also spatially map the shallow to intermediate depth b-value in the crust for Kutch region. B-value shows a significant change as a function of time and space both. Highly significant variations in b-

values are found for both Spatial-temporal distribution and for depth when analyzing data.

Spatial-temporal variations in the b-value is important and may reflect the rupture process of the main shock and direction of stress drop and helps to understand how earthquakes grow and stop and thus helps to predict future events and variations in b-value with depth explains the crustal heterogeneity in the aftershock region. These results confirm that the b-value should not always be considered a constant and the variation in b-value should always be considered in the studies such as seismic hazard estimations.

7 Probing the K-T transition boundary in Mawsynram area of Assam-Arakan Basin, Shillong Plateau, India.

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Key Words: K-T boundary, Shillong Plateau, PGE, Trace-REE and Hiatus.

A ~1.5 cm thick limonitic layer is discovered within a medium to fine grain carbonaceous sandstone-shale thin alternation unit (~60 cm thick) from Langpar Formation of early Tertiary period. The ICP-MS analysis for PGE's shows that this particular limonitic layer has higher Ir (iridium) concentration than the other shale/clay rich sedimentary layers present in the litho-stratigraphic column and can be demarcated as the geochemical boundary of K-T (Cretaceous-Tertiary) transition period in Mawsynram area of East Khasi Hills District, Meghalaya, India. Besides these, field observations clearly shows that this limonitic layer is 20m above a

well marked hiatus/ erosional contact present between the late Cretaceous Upper Mahadek sandstone (glaucconitic sandstone) and the early Tertiary Langpar sandstone which marks the litho-stratigraphic boundary between the Cretaceous and the Tertiary rocks in the area. Petrographic study of sandstones in the litho-column indicates short distance transportation of these sediments and/or near source sediment deposition having mixed provenance of igneous and metamorphic rocks. The Trace-REE study in this K-T litho-column also marks a prominent stratigraphic variation of La/Sc, Th/Sc, Th/Co, Th/Cr, Eu/Eu* and Cr/Ni, indicating change in rock composition from mafic to felsic components just above the hiatus.

So, from the present study conclusions can be drawn that a well marked hiatus/erosional contact exist between the Upper Mahadek and Lower Langpar formations of Cretaceous and Tertiary period respectively representing the litho-stratigraphic boundary and 20m above it is the chronostratigraphic boundary marked by a limonitic layer having higher Ir concentration and defining the K-T transition in the area.

8. Impact of Environment on Malaria: A Case Study of Bharias of Tamia, Chhindwara (M. P.)

Arvind Solanki & Prof. Kailash Choubey
Department of Geography, Dr. H. S. Gour V.V. Sagar M.P.

Key Words: Malaria, bharia-tribe Tamia

Tamia is a tribal community block of Chhindwara district, because it has more than 85 percent unique tribal population of Bharia tribe. Geographically, Tamia is situated between 22° -20° northern latitude and 78° 25' - 79° in eastern longitude. It extends over an area of 1268.02 km², which is about 9.32 percent of the

district geographical area. Malaria is a febrile disease caused by the four species of plasmodium parasites to host by the bite of an infected female mosquito of the genus Anopheles. Early symptoms of malaria include fever, shivering, aches, and pain in the joints and headache. In P. Falciparum malaria, infected red cells can obstruct the blood vessels of the brain, causing cerebral malaria, which is often lethal. Other vital organs can also be damaged, with fatal consequences.

Bharia is one of the important tribal groups of Tamia, Chhindwara district which suffered with malaria from a very far time due to the environmental factors of Tamia block. Tamia is surrounded by hills and forests and provide favorable environmental conditions for malaria occurrence. The Tamia block is considered for national Malaria Control Programme (NMCP/NMEP) from 1960s, but a huge amount of population is always suffered with the disease. So it is necessary to study the environmental factors of Tamia block on malaria disease among Bharia.

9. Surface resistivity investigations for estimation of aquifer hydraulic parameters in the Bhuleshwari river basin, Amravati District, Maharashtra.

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603.

Keywords: Groundwater exploration, Geoelectric method, Resistivity sounding, Hydraulic properties, alluvial aquifer, Bhuleshwari river basin, Amravati district.

In the present paper attempt has been made to integrate geophysical resistivity data with direct hydrogeological measurements and characterize the subsurface lithology. Detailed local geological, geophysical, and hydrogeological investigations

were carried out for the alluvial aquifer in the Bhuleshwari river basin, Amravati District, Maharashtra, to delineate the architecture of different subsurface geological horizons using lithologs and generated vertical electrical sounding (VES) data. An attempt has also been made to estimate aquifer transmissivity from resistivity data. The data obtained were interpreted by computer iterative modeling with curve matching for calibration purposes. In order to ascertain the subsurface geological framework, geoelectrical sections were prepared. Probable aquifers were identified from these sections. Transmissivity of the unconfined aquifer was determined using the Dar- Zarrouk parameters and actual pumping test. The transmissivity values in the aquifers vary from 1223 to 6,694 m²/day, and K varies from 10.56 to 54.0 m/day in the study area.

10 Fossil calcareous algae from the hydrocarbon-potential sedimentary basins of India and their palaeoecological implications

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KeyWords- Calcareous Algae, Sedimentary basins, India,
Palaeoecology, Palaeobathymetry

The sedimentary basins of India have been classified by ONGC into four categories based on their hydrocarbon potential. Fossil corallinacean red algae and halimedacean green algae belonging to Cretaceous and Palaeogene-Neogene sediments have been reported from three categories viz., Cauvery and Assam Shelf (Category-1), Kachchh and Andaman-Nicobar (Category II) and Narmada (Category IV). The present paper deals with the diversity, growth-form and taphonomic analysis of these calcareous algae. An

attempt has also been made to throw light on the palaeoecological and palaeobathymetric significance of algal rich sediments from these basins.

11 Energy Balance Approach for Snowmelt Runoff Estimation

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A physically based UEB model is used to simulate the energy exchange processes and estimate the amount of snowmelt generated in Manali sub-watershed. The SCA was estimated from remote sensing technique by calculating NDSI with incorporation of NDVI to account for the snow over vegetation and weekly SCA maps are obtained by linearly interpolating these snow cover maps. LULC map was obtained from IRS P-6 LISS-III using visually enhanced fused ALOS PRISM and IRS P-6 LISS-III image. The UEB model's initial results showed diurnal variations in melt which were in accordance with the flow trends in the study area. *Index Terms* — Snowmelt, Energy Balance, Snow Cover, Image Fusion, UEB Model.

12 Hydrocarbon Potential of Deep and Ultra Deep Water Regime of Eastern Continental Margin of India (ECMI)

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Key words: Deep water, Hydrocarbon, 85 degree East Ridge, prospective

Recent discoveries of giant sized gas field in Krishna-Godavari basin have shifted the focus for hydrocarbon exploration towards the vast unexplored deep water sediments of Bay of Bengal. Integrated studies reveal that 85 degree East Ridge related plays in the Mahanadi offshore looks very promising. Thick sequence of Tertiary sediments characterized by presence of deep water channel complex along with the toe thrust structure related to shale movement have been interpreted to be prospective in Krishna-Godavari basin. To the south in Cauvery basin structural closures in rift related horsts along with deep water channel complex are the future frontiers.

13 Cyanobacteria rich sediments from the Subathu Formation (Early Ypresian) of Lesser Himalaya, India: Palaeoenvironmental implication.

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Key words: Cyanobacteria, Subathu Formation, Early Ypresian, Palaeoenvironment

The present paper deals with the Cyanobacteria rich sediments recorded from the basal part of the Subathu Formation (Early Ypresian) from several measured stratigraphic sections of Uttarakhand, Himachal Pradesh and Jammu&Kashmir, throwing lights on its significance in palaeoenvironmental interpretations. Two types of Cyanobacterial fabric were documented in this horizon viz., Microbial mats and Cyanobacterial nodules. Palaeoenvironmental reconstruction based on the recovered Cyanobacteria suggests that these sediments were laid down in protected areas of low relief intertidal –supratidal regions during initial transgression of the Subathu Epicontinental Sea. The climate was exceptionally warm and humid followed by mild dry intervals.

14 Microstructural and Chemical investigations of Spessartine in Gangpur Group of rocks, Orissa

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Key words : Manganese ores, garnet, genesis, Goriajhar Formation, Gangpur Group

Spessartine, the manganese garnet, is reported from Panchra-Bargaon-Salebira area belonging to the Goriajhar Formation of Precambrian Gangpur Group in Sundargarh district, Orissa, These garnets, occurring in two mineral assemblages: spessartine-tephroite and spessartine-rhodochrosite, are metamorphosed to green schist facies conditions. Spessartine occurs either as large anhedral crystal or small idiomorphic crystal in the tephroite paragenesis and its mol.% is dominated by spessartine, followed by grossular, andradite, almandine and pyrope. In the rhodochrosite paragenesis, zoned garnet crystals or aggregates of them showing variation in the spessartine-calderite content of the solid solution is observed. Genetic implication of these microstructural-molar-compositional variations has been discussed.

15 Metallogeny in Singhbhum: a boon for India

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Keywords: Geology, Metallogeny, Singhbhum provenance, Minerals, Stratigraphy Shear zone

There was multiple metallogeny epochs in the Singhbhum province in the Jharkhand state of India. As a result it is a well known repository of the richest mineral heritage of India, related to extensive structural activities in the Archaean. Its geological aspects draw the attention of the entire world. It has attracted many companies, such as TISCO, SAIL, UCIL, HCL, Mittal Steel, JSW, JSPL etc. The province, divided into smaller districts (East & West Singhbhum, Seraikella, Mayurbhanj, Keonjhar) is geologically considered as one unit, with Northern Singhbhum Mobile Belt in the north and Singhbhum Craton in the south. This paper correlates metallogeny with mineral deposits of shear zone of Singhbhum.

16 Why women do not opt for the profession of scientific research

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In today's era, women are not only confined to household work but they have also made significant contributions in each and every sphere of life e.g. education, banking, medical sciences,

Science and Technology, law, management & armed forces etc. In spite of all these facts, the presence of women is very less in Science and Technology as compared to other professions. In the present time, when the whole world is saluting the women as women empowerment to emerge them in terms of power & courage for facing the numerous challenges of life.

Women residing in rural areas are yet quite away from various facilities alike urban ones. The poor economy, health and educational background etc. lowers their quality of life. In such type of circumstances, the parents are bound to provide their daughters only Arts and Commerce schooling. In the most of the cases, they are unable to teach/provide their (girl) children the study of Science & Technology or in other terms in scientific research due to traditional thoughts, lack of motivation, expensiveness, unavailability of concerning facilities at local levels, marriage and other such rituals etc. If proper attention is focussed/given by Govt. & policymakers on these above mentioned points; no doubt, the presence of women in scientific research will be rapidly increased.

17 Relative Vulnerability and Risk Assessment of Flood Hazards of Orissa

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Orissa is one of the states along the east coast of India with a huge network of rivers and deltaic stretches and is located in a humid tropical region. The state has been recurrently affected by flood hazards from its rivers many of which have turned into disasters with wide spread damage to property and loss of human life. Besides this, the impacts on livelihood, damage to housing and

crops are also the major concerns of the people and the state as well. This paper examines some methodological application of the Disaster Risk Index (DRI) to improve understanding of the relationship between development and disaster risk.

The major assumption behind the DRI is that differences of risk levels faced by different regions with similar exposures to natural hazards are explained by socio-economic factors, i.e. by the population vulnerability. It can allow measurement and comparison of relative levels of risk, exposure to hazards and vulnerability at different spatial levels. The DRI can also contribute to a more quantitative evidence for planning and decision making in the field of disaster risk reduction and management. The findings of this study can be useful for development of more effective hazard management policies, programs and strategies in the state.

18 Study of River Basin Using Basin Asymmetry and Hypsometry

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Keywords: basin asymmetry, hypsometry, hypsometric curves

The present study highlights the application of Basin Asymmetry and Hypsometry in the study of river basin. The study area is a part of the Imphal river system located along the proclinal Churachandpur-Mao-Thrust (CMT) in the tectonically active zone of Indo-Myanmar region. The Basin Asymmetry analysis is carried out on the 2 Basins of Strahler order 7 with the value of T-index calculated at a distance of 2km using TecDEM. Three anomalous locations are able to identify where asymmetry vectors approach

zero suggesting a strong influence of drainage on the tectonic features at these locations, most probably a consequence of river capture. Further, the hypsometry is studied in 8 basins of Strahler order 6 by generating hypsometric curves using the TecDEM. The hypsometric curves reveal that the oldest basin belongs to the southern part while the youngest belong to the northern side.

19 Study of 6th Mile Landslide/ Subsidence in the Mid-Himalayan Watershed of Rongni Chu in East Sikkim Using Remote Sensing and GIS Techniques

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Landslides, flash flood, soil erosion, earthquakes, Glacial Lake Outburst Floods (GLOF) and Landslide Lake Outburst Floods (LLOF) are the prominent environmental hazards affecting the people and the communication systems of the Indian Himalayan states. Apart from these; the incidents of avalanche is also an important natural hazard in the alpine and sub-alpine areas of Sikkim (Dahal et.al. 2010). Triggering factors of landslides includes young and unstable geological structure, unusual behavior of rainfall, steep slope, and aspect, varying land use, proximity to road, lineaments, landforms and drainage. Owing to advancements in the field of remote sensing and GIS techniques, it is easy to map, locate and develop the spatial information based on them and to understand the mechanism causing landslides.

6th mile landslide / subsidence is characterized by the presence of varying cracks, road sink, fragile geological rocks, maximum tilt of trees, formation of lineaments, emergence and sub-

subsurface flow of new streams. Prominent trees in the landslide / subsidence are *Alnus nepalensis*, *Schima wallichii*, *Terminalia myriocarpa*, *Betula* sp, *Engelhardtia spicata* *Prunus cerasoides*, *Ficus lacor*, *Machilus edulis* belonging to temperate mixed forest. The movement and subsidence is well noticed by the widening of road cracks in the monsoon months , tilt of the trees and the buildings below and above NH- 31A. The tilt of trees and cracks in the landslide / subsidence differs from crown to toe (64 cm in the middle to 74 cm near the confluence of streams; concentration of cracks is highest in the middle part of the landslide / subsidence with variation of length from 26 cm to 14 cm in the middle to 20 to 8 cm in the lower portion). The altitudinal zone (1100-1150 meters) occupies the largest area (6.34 ha) in the landslide /subsidence. The average tilt angle of the trees was calculated as 22.41°. The coefficient of range for the relative relief of the landslide /subsidence was calculated as 0.23 meters. However, the coefficient of range for the slope and aspect was calculated as 0.93 and 0.97 respectively.

20 Use of waste plastic and tyre in Pavement Systems

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Reinforcement of soils with natural and synthetic fibres is potentially an effective technique has been suggested for a variety of geotechnical applications to sub grade /sub base stabilization of pavements demonstrated the capability of synthetic fibre reinforcement for improving the behaviour of sand by using triaxial tests, CBR tests, cyclic triaxial tests, resonant column and torsional shear tests. These studies indicated that fibre inclusions increase the ultimate strength, stiffness, CBR .resistance to liquefaction, shear modulus and damping of reinforced sand. The fibre reinforcement

generally increases the ultimate shear strength and also limits the reduction in the post peak shearing resistance of the soil specimen. In the present work an attempt has been made to reinforce gravel sub base with waste plastics and waste tyre rubber separately in the model flexible pavement system laid on expansive soil sub grade.

In order to find the optimum percentage of waste plastics and waste tyre rubber having maximum shear strength and CBR values, direct shear tests and CBR tests were conducted by using different percentages of waste plastics and waste tyre rubber mixed with gravel. The following results and conclusions may be obtained from the present study

1. It is observed that from the results of direct shear tests of direct shear tests and CBR tests for gravel material reinforced with diff. percentages of waste plastics and waste tyre rubber, the optimum percentage of waste plastics and waste tyre rubber reinforcement are equal to 0.3% and 5.0% respectively.
2. No significant control of heaving was observed in the laboratory model flexible pavements when gravel reinforced with waste plastics and waste tyre rubber chips were laid over expansive soil sub grade.
3. The load carrying capacity of the model flexible pavement system significantly increased when the sub base was reinforced with waste plastics as well as waste tyre rubber when compared to unreinforced sub base.
4. From the loading-unloading test results, it was observed that, waste plastics reinforced model flexible pavement had marginally better performance in comparison with waste tyre rubber reinforced model flexible pavement. At all the deformation levels ,gravel reinforced with waste plastics has shown better load carrying capacity as compared to gravel sub base reinforced with waste tyre rubber.

21 Experimental Investigation of Control of NO_x Emissions in Diesel-Fueled Compression Ignition Engine

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Diesel fueled engines produce less carbon monoxide (CO), unburned hydrocarbon (HC), and particulate emissions but with higher NO_x emissions. Exhaust Gas recirculation (EGR) is effective to reduce NO_x from diesel engines because it lowers the flame temperature and the oxygen concentration in the combustion chamber. However, EGR results in higher particulate matter (PM) emissions. Thus the drawback of higher NO_x emissions while using diesel may be overcome by employing EGR.

The objective of this project work is to investigate the usage of diesel and EGR Simultaneously in order to reduce the emissions of all regulated pollutants from diesel engines. A single cylinder, water cooled, high speed direct injection diesel engine was used for experiments. HCs, NO_x, CO and smoke opacity of exhaust gas were measured to estimate the emissions.

Various engine performance parameters such as brake thermal efficiency, brake specific fuel consumptions (BSFC), and brake specific energy consumptions (BSEC), etc were calculated from the acquired data.

The experimental results show that EGR with diesel resulted in reductions in NO_x emissions without affecting any performance and slightly increased in smoke opacity. 15% of EGR gives better performance in terms of NO_x and smoke compared to 11%, 23% and 30% of EGR.

**22 An Electronic System with device for Pollution Control -
Electronic pollution control system**

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The emerging world has been covered with a new blanket along with the atmosphere, in the recent times and that blanket is named "POLLUTION". And measures have been taken in recent times, to the core, to control and enroll certain measures to remove the blanket and it is successfully on way.

Here this is a part of it. This Electronic Pollution control system has been designed for the above purpose. This has a gas detector in the exhaust tube of every vehicle in case of automobile and in the chimney top, in case of different petro-chemical industries, which top the table of leading polluting industries. This sensor will monitor the toxic gases coming through the exhaust and give an electronic output, which will be monitored by small software.

Now when the output from the sensor for a particular season, or a particular period of time goes beyond the safer value, an ANALOG signal will be sent to the nearest transport or police department, with the help of an artificial SIM, equipped in the car. This signal has data regarding the owner's license, bank account number etc details, which helps them to take action on that vehicle.

23 Estimation of Depth and Sedimentary Thickness of Lake Using Ground Penetrating Radar (GPR)

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Keywords: GPR, lake, depth, profile, sediment

The study is carried out in Punem Lake located in the state of Manipur that is believed to be originated by damming of paleo-channel caused by the tectonic activities. The study aims to find out the depth and the sedimentary thickness of the lake. Radar profiles are obtained in the lake using 100 MHz RTA. The data are processed and interpreted using RadExplorer developed by Mala Geosciences. The Lake is a shallow one and the depth is found to be around 2.2 m with the sedimentary thickness ranging from 2.2 m to 3.8 m. Secondary reflections are also distinctly visible at around 4.2 m and extends upto 5.4 m.

24 Global Positioning System (GPS) Research for Earthquake Studies in Mishmi Block, Arunachal Pradesh

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Keywords: Mishmi block, Himalayan ranges, GPS, velocity.

The permanent GPS station at Anini, Mishmi block shows the Eastern Himalayan belt and Indo Myanmar Arc are linked with the presence of Mishmi suture. The ongoing deformation tectonics of both the belts is controlled by the presence of the Mishmi suture

zone. The sharp twisting of the Himalayan ranges as they turn from a southeasterly to a southerly direction and descend rapidly to China and Myanmar. The Mishmi block moves at the rate of 20.1344 mm/yr and 42.18⁰ N azimuth which seems to be quite different with the deformation rates of Himalayan belt. GPS campaign mode has been conducted with twelve (12) sites in the Mishmi block to get a more accurate result.

25 Comparison of Slope from Multiscale Dems

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Keywords: DEM, ASTER, SRTM, Slope

In this study Digital Elevation Models (DEMs) obtained from three different sources viz 20m contours of 1: 50000 scale Survey of India Toposheet, 30m ASTER data and SRTM 90m are used for comparison of slope. The slope has been generated from these DEMs using ARCGIS and the variation in slope ranges and the area are calculated. From the study it is found that the slope obtained from each DEM shows variation in the value that ranges from 0-75, 0-73, and 0-60 in the 20m, 30m and 90m DEM respectively. Further, it is also observed that the area in each slope classes also varies drastically.

26 Shifting Cultivation in Relation with Soil Types in Manipur River Basin: A GIS Approach

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Keywords: GIS, Remote Sensing, Shifting Cultivation, Soil Types, Soil Map of NBSSLUP, Manipur River Basin.

This paper emphasises on the relation of shifting cultivation with the soil types in which the crops are cultivated in the Basin of Manipur River using the GIS and Remote Sensing techniques. The LANDSAT satellite imageries of 1988 and 2000 along with IRS-1C LISS III imagery of 1998 and 2003 are used to perform temporal change analysis to find out the trend of shifting cultivation in relation with the soil in these study periods. During the present study, the total shifting cultivation area was found to be about 128.54 Km², 176.16 Km², 242.46 Km² and 394.07 Km² in the year 1988, 1998, 2000 and 2003 respectively. During 1988 shifting cultivation was found minimum in Soil Code-004 with an area of 0.047 Km² and maximum in Soil Code-012 with an area of 43.46 Km². The soil type remained the same for maximum with an area of 25.76 Km² during 1998. During 2000 maximum shifting cultivation was found in Soil Code-013 with an area of 33.31 Km² and for the year 2003, maximum shifting cultivation was found in Soil Code-013 with an area of 77.88 Km². The remote sensing data coupled with GIS techniques have been quite helpful in studying the impact of shifting cultivation in the area.

27 Study of Urban Sprawl Using Remote Sensing and Shannon's Entropy

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Keywords: urban sprawl, remote sensing, Shannon's Entropy

This paper is an attempt to study the urban sprawl using multi temporal remote sensing data of different satellites. The study is carried out in part of the capital city of Manipur, the Greater Imphal Area (GIA). In this study, satellite data of IRS-P6 LISS III (2008) & LANDSAT (TM-1988, ETM-2000) are used to generate the respective NDVIs to isolate the urban areas from other classes of the area. From the study it is found that the urban area is steadily increasing to 1423.4ha from 1988 to 2000 and 779.9ha in 2000 to 2008 with encroachment in the agricultural area and swampy area. Besides, computation of Shannon's Entropy also indicates the occurrence of entropy in the area. The total entropy value of 0.6 in 1988 and 1.0 in 2011 and 2008 indicates the occurrence of sprawl in the area. The higher value of 1.0 in the later two years indicates higher rate of sprawl and a highly dispersed development from the centre or core of the city. From the study it is found that using remote sensing in conjunction with Shannon's Entropy is a good exercise in the study of urban sprawl.

28 Organic geochemistry and hydrocarbon potential of coals from Laitryngew coalfield, East Khasi Hills, Meghalaya

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Key words: Coal, Eocene, hydrocarbon potential, Rock-eval pyrolysis

The Laitryngew coal field is a part of the Cherrapunji plateau and falls in the East Khasi Hills District of Meghalaya. The coal deposits in and around Laitryngew are located between the 25° 17'-25° 21'N latitudes and 91° 42'-91° 45'E longitudes and included in the Survey of India Toposheet no. 78O/11. The coal occurrences in the area can be approached by the Shillong-Cherrapunji Road at a distance of 43km from Shillong towards south. The coal occurrences in the coalfield field belong to the Lakadong Sandstone Member of the Sylhet Formation of the Jaintia Group of Eocene age. It appears from the disposition of the rock formations that the Cherrapunji plateau is little bit tilted towards the south at an inclination 4-6°. There are no major structures like fault or fold is found in the near vicinity of the coalfield. The occurrences of coal seams are very sporadic in nature in the coalfield. Coal seams are found in the flat topped hillocks, while they are absent in the low lying depressions. There are altogether three coal seams in the area. The lower seam is the most persistent coal seam in the area and thickness ranges from 0.3 to 0.9m. The thickness of the middle seam ranges from 0.15 to 0.6m and not as persistent as the lower seam. The top seam is found in few locations only and ranges from 0.1 to 0.3m.

Sixteen channel samples of coal from the coalfield were studied by Rock-Eval for determining hydrocarbon potential. The total organic carbon (TOC) values range from 20.57 to 54.62% (averaging 54.62%), which is much higher than the threshold value of 0.5% required for a potential source rock to generate hydrocarbon. The genetic potential (GP) and hydrogen index (HI) range from 5.09 to 183.20 mg HC/g rock and 11.25 to 318.27 mg HC/g rock respectively. The organic matter is predominantly gas prone. The Tmax value range from 421 to 432°C indicating immature nature of the coal as source of hydrocarbon. However, a complete petroleum system is not developed in the coal bearing areas of the Khasi Hills region due to general absence of reservoir and cap rock horizons above the coal measures.

29 Energy Conservation, Pollution Control and Zero Maintenance through Green Buildings

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Green building is the practice of increasing the efficiency with which buildings and their locations use energy, water and materials, as well as, reducing the impact of buildings on human health and the environment, through better siting, design, construction, operation, maintenance, and removal of buildings. The energy crises of the 1970's spawned research into green building, with the development of new glazing technologies and solar designs, as well as the development of natural cooling, ventilation and daylight systems. Many private sector and government funded demonstration projects were built at this time and in the decades that followed. Worldwide, the building and construction industry consumes more fossil fuels and natural resources than any other human activity.

Green building is the term that refers to designing and building structures that are environmentally sound and follow the tenets of sustainability. Such buildings consume less energy, are durable and can be recycled. The construction, maintenance and demolition of buildings consumes a tremendous amount of energy and resources. Building green is important to the protection of ecosystems, to maintain safe air and water quality, and to conserve renewable and nonrenewable natural resources. Energy efficiency and resource conservation also play a vital role. Green building is an immediate, measurable, and cost-effective solution to the complex and interrelated issues of climate change, energy dependence, and human health.

The cost of green buildings is generally overestimated. The additional cost for incorporating green design will be only 5 to 6% of the total cost. This will be offset by the reduced costs of operation and maintenance. Cost of lighting, heating/cooling, water supplied will be much less than that for the conventional buildings. With the costs of cement and steel sky-rocketing, green buildings will prove to be cost effective. **The Energy Conservation Building Code (ECBC)**, launched on 28th June 2007, is a document that specifies the energy performance requirements for all commercial buildings that are to be constructed in India. The concept of green building minimises environmental degradation. In India, there are many green buildings like the new **Shamshabad Airport in Hyderabad, TATA Energy Research Institute, Gwal Pahadi, Gujarat Energy Development Agency (GEDA), Medicity in Hyderabad etc....**

Practitioners of green building often seek to achieve not only ecological but aesthetic harmony between a structure and its surrounding natural and built environment, although the appearance and style of sustainable buildings is not necessarily distinguishable from their less sustainable counterparts. **Thus this paper throws** light on the aforementioned matter.

30 Assessment of Forest Cover in Bishnupur District of Manipur

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Keywords: Forest cover assessment, Normalised Difference Vegetation Index, reforestation, afforestation

This paper mainly deals with the forest cover assessment of Bishnupur district of Manipur since 1997 to 2007 using the ancillary data analysis and satellite data with the help of Normalised Difference Vegetation Index. The forest cover of the present study area is 5 km² (1.00%) and 0.02% of state's geographical area in 1999 but in 2007, the district's forest cover is 25 km² which is 40% of its geographical area and 1.15% of state's forest cover. During this 11 years there is gain of 20 km² forest cover of Bishnupur district. The gain in forest is mainly due to the reforestation and afforestation programmes taken by Forest Department of Manipur and nearby villagers.

31 Tsunami warning system to mobile (*Embedded system for protecting mankind from earth quake disasters*)

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The term *tsunami* originates from Japanese and means "harbour wave". It is a series of waves when a body of water, such as an ocean is rapidly displaced on a massive scale. Tsunamis cannot be prevented or precisely predicted, but there are many

systems being developed to warn and save the people of regions with a high risk of tsunamis before the wave reaches land.

32 Soil-Cement-Bentonite Slurry Walls

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Soil-Cement-Bentonite (SCB) slurry walls have been used with increasing frequency in recent years to provide barriers to the lateral flow of groundwater in situations where the strength of a normal soil-bentonite wall would be inadequate to carry foundation loads.

The addition of cement to the backfill blend allows the backfill to set and form a more rigid system that can support greater overlying loads.

Construction and quality control for the SCB wall is more demanding than that needed for conventional soil-bentonite slurry walls. Backfill mixing, sampling and testing of this type of wall involve more exacting procedures. Recommendations are made herein for methods to carry out pre-job design mix testing and in-field quality control testing for the most reliable results.

Designing the SCB backfill is a complex issue involving conflicting actions of the various materials involved. While the SCB wall provides additional strength, permeability is one property that generally suffers in comparison to soil-bentonite slurry walls. A normal permeability specification would be a maximum of 1×10^{-6} cm/sec. With special attention to materials and procedures, a specification of a maximum 5×10^{-7} can be achieved.

Data are presented from design mix studies and field-testing programs to illustrate the effect of increasing concentrations of the key materials in the mix design and also the impact of other factors such as time on the measured properties. Comparisons are made between soil-cement and SCB materials as used in slurry walls and other types of installations. The SCB material is normally highly variable, even when mixed under carefully controlled conditions; engineers must account for this variability in designs and when drafting specifications.

33 Remote Sensing and Geotechnical Information Technology-A Case Study on Kolleru Sanctuary

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Remote sensing means the process of acquiring information about any object without physically contacting it in anyway regardless of whether the observer is immediately adjacent to the object or million of miles away.

Remote sensing data basically consist of wavelength intensity information acquired by collecting the electromagnetic radiation leaving the object at specific wavelength and the measuring its intensity.

To know the geographical information about art, science, engineering & technology GIS system is used. GIS is a generic term denoting the use of computer to create and depict digital representation of the earth's space.

GIS has the roots for the development of remote sensing, in the late 1960's and early 1970's, as a potentially cheap and effective source of earth observations.

While many of techniques for processing remote sensing data are highly specialized, more general GIS techniques become important in order to combine information desired from remote sensing with other collateral information.

GIS has many roots of evolution like map production process. The root of large scale data integration around a common data model & possibility storing large number of layers of information.

34 Optimum Utilization of the Solar Energy by Employing the Design of “Passive Solar Buildings” in the Building Construction

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Raghavendran Tata**

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Passive Solar Energy Heating of Interior Air in a cold climate is extremely easy and inexpensive to implement. Passive Solar Energy Heating begins with vertical equator-side (south-facing) glass (or north-facing glass in the southern hemisphere). The winter sun is quite low often less than 30 degrees above the horizon in the winter. Direct sunlight easily penetrates vertical glass and can heat a room well above 80 degrees F, when it is below freezing outside. When there is snow on the ground, the reflection of the low winter sun off of the snow significantly increases the Passive Solar Energy Heating effect, with reflected sunlight on your interior ceiling. In the summer, the noonday sun is 47 degrees higher than in the winter. Place-based, location-specific overhangs are designed

above the equator-side windows, so that no direct sunlight can enter the glass in the summer, when the sun rises in the northeast, is nearly straight overhead at noon, and then sets in the northwest. Understanding the precise seasonal path of the sun in your location is critical to effective passive solar energy heating, and passive solar energy cooling, especially in hot humid climates. Roof-angled glass should always be avoided in all locations. Roof-angled glasses are a solar furnace when the summer sun is nearly straight over head. Most of low winter sunlight reflects off of roof angled glass due to the nearly-parallel “angle of incidence”.

In the winter, warm air rises and the hottest air in the room touches your ceiling glass. This creates high heat transfer, large energy bills, due to the large temperature differential across the ceiling glass, which has low resistance to heat flow. Roof-angled glass is like a thermal hole in your ceiling / roof. Instead of having only one wall between your interior and the summer / winter outside temperature extremes, our Passive Solar Energy Homes have two layers of glass. The engineering principle is that two small temperature differentials produce much lower heat transfer than one large temperature differential as in the case of a traditional building with no Thermal Buffer Zone on any side. Passive Solar Energy Home, we generally design in a Solarium with a lot of protected vertical glass on the equator side of the thermal envelope. It is important that it be Isolated from the interior (sleeping quarters) of the home. The Solarium then acts as a Thermal Buffer Zone– at moderate temperatures that are typically between interior and exterior temperature extremes. There is then a lot of interior glass that divides the Solarium / Greenhouse space from the interior of your home. Instead of having only one wall between your interior and outside temperature extremes, you have two layers of glass. The engineering principle is that two small temperature differentials

produce much lower heat transfer than one large temperature differential.

35 **Ground Improvement Techniques**

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Ground improvement is the most imaginative field of geotechnical engineering. It is a field in which the engineer forces the ground to adopt the project's requirements, by altering the natural state of the soil, instead of having to alter the design in response to the ground's natural limitations. The results usually include saving in construction cost and reduction of implementation time.

There are number of techniques available for improving the mechanical and engineering properties of the soil. However, each technique has some limitations and suit abilities to get maximum improvement in the soil conditions with minimum effort. Some of the important techniques are discussed in this paper.

To improve the strength of the soils, especially in case of granular type of soils, COMPACTION METHODES are found as best methods among all type of techniques. Based on the mechanism applied for compacting the soil, it is sub divided into different methods like dynamic compaction, blasting, vibro techniques ...etc.These are briefly discussed in this paper.

When there are some limitations encountered for applying the above technique, grouting techniques, stabilization of soil using different admixtures can be adopted effectively which can bring

variations in the soil conditions. The various types of above techniques are briefly discussed in this paper.

Finally, recent advancements in ground improving techniques using GEOTEXTILES, ELECTRIC TREATMENT METHODES are also briefly discussed in this paper. These techniques are widely used in these days.

36 Indian Ophiolites : A Target LOCI For Mineralization

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Key words: Indian Ophiolites, PGM, Chromite, Phulad ophiolite, Manipur ophiolite.

The ophiolite are a section of the earth's oceanic crust and the underlying upper mantle that has been uplifted or emplaced to be exposed within continental crustal rocks. Ophiolites are characterized by a distinct assemblage of rock types, consisting of deep sea sediments overlying basaltic pillow lavas, sheeted dykes, gabbros and ultramafic peridotites. Ophiolites are being considered as pieces of oceanic crust that have been obducted on to the edge of the continental plate. The occurrence of ophiolite in older rocks presumably represent the erosion rate of high-level nappes, flanking the core of orogenic belts, in which the larger ophiolite bodies usually occur. The ophiolite emplacement mechanism still remains elusive. Among many plate tectonic models to include, first, fast spreading ridge; second, slow spreading ridge; third, spreading ridge between continental fragments; fourth, SSZ type spreading and fifth, collapse of a spreading ridge. None of these models are universally accepted. Important global ophiolite are Troodos ophiolite (Cyprus), Oman ophiolite (UAE) and Lizard point (U.K.).

In India a prominent ophiolite belt named ‘Manipur-Nagaland ophiolite’ extend for 200km with 15 km width. Another belt, occurs as ‘phulad ophiolite’. Both, have characteristics lithology and potential of mineralization. Chromite deposit may constitute an integral part of orthomagmatic deposit, where crystal-liquid equilibria dominant in mafic rocks of ophiolite. The process of formation of platinum mineralization in complexes of the Alpino type hyperbasites is an integral part of the general process of formation of chromite ore accompanying dunite like components of Ophiolites. Also there are number of Platinum groups of element (PGE) oxides and hydroxides which have been discovered in ophiolite complexes. Massive stratabound sulphide deposits within the volcanic sections of ophiolite complexes are also well known. Hence, petrogenesis and tectonic setting of Indian ophiolites is a favourable target loci for important mineralization.

37 Designing of super efficient homes for creating Eco-Friendly Buildings and Promoting Energy Conservation

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An efficient home is a general term applied to a building with a net energy consumption of zero over a typical year. This can be measured in different ways (relating to cost, energy, or carbon emissions) and, irrespective of the definition used; different views are taken on the relative importance of energy generation and energy conservation to achieve energy balance.

The efficient approach is promoted as a potential solution to a range of social and environmental issues, including reducing carbon emissions, reducing dependence on oil power, fuel imports,

and the use of fossil fuels in general, and providing a measure of energy security against future energy crises. The super efficient home is a low energy demonstration project to show how renewable energy can create a unique living experience and conserve the environment. A holistic approach has been taken to eliminating household carbon emissions that would normally result from cooling, powering the home.

38 Measurement of Radon activity concentration and Radium content in soil samples of Nongrah, Shillong

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Keywords: Radium, LR-115, Radon activity concentration, Radon exhalation rate

Radon-222 is a gaseous radioactive element, a direct product of the decay of radium-226, which is present in all terrestrial materials. When radium decays within the recoil distance of the grain surface the atoms of the radon are released from the solid matrix of the material into the pore space due to the recoil action. Radon atoms entering the pore space are then transported by diffusion and advection through this space until they in turn decay or are released into the atmosphere through exhalation. Thus, the distribution and concentrations of the parent Radium content in the mineral grains primarily govern the Radon activity concentration in the soil environment, which in turn influences the radiation levels indoors. As Radon and its progeny are major sources of total natural radiation exposure (> 50%) to humans; radium estimation in the soil

samples and radon activity concentration measurement is important for public health risk assessments. The present work has been conducted for 7 months in the Nongrah region of Shillong at 8 different sites. The measurement of Radon activity concentration in soil-air is carried out using PVC pipe Technique and the Radium Content is measured using Can Technique. The Kodak LR-115 (Type II) is the Solid State Nuclear Track Detector used in both the techniques. The geometric mean values of the Radon activity concentration and the Radium Content in 8 sites are found to vary from 1690.39 to 10547.26 Bq.m⁻³ and from 3.75 to 19.37 Bq.kg⁻¹ respectively. The Radon exhalation rate falls within the range 29.66 to 160.17 Bq. kg⁻¹ h⁻¹. A significant positive correlation has been observed between Radon activity concentration in the soil-air and Radium content of the soil samples in the study sites.

39 Potential Alpha Energy Concentration in some Schools of Shillong City

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Keywords: Radon, PAEC, AEDE, Schools.

Radon and its progeny are the most significant source of natural radiation. Radon being ubiquitously distributed, its exposure cannot be avoided. The deposition of the inhaled short lived decay products of radon along the walls of the various airways of the bronchial tree provide the main pathway for radiation exposure of the human lung, significantly increasing the risk of lung cancer

(UNSCEAR, 2000). Indoor radon levels can build up to harmful levels whereas in outdoor environment radon is quickly diluted and is of no major radiological concern. Hence the importance of assessing radon levels in indoor environments, in particular schools, as children have smaller lung volumes and higher breathing rates resulting in a higher radiation dose.

In our study, we have surveyed 20 schools in Shillong City for the assessment of radon levels, using the SSNTD method with LR-115 Type II detectors. The results obtained are expressed in terms of the Potential Alpha Energy Concentration (PAEC), which is a measure of the human exposure to radon and its decay products through inhaled air. The PAEC (mWL) values obtained from the survey are found to range from 2.56 - 58.2 mWL (Arithmetic mean) and 2.34 - 58.18 mWL (Geometric mean). The dose due to the measured exposure in the schools under study are calculated in terms of Annual Effective Dose Equivalent (AEDE) and are found to be lower than 30 mSv.y^{-1} , the prescribed action limit by AERB.

40 Petrochemical characterization of Bathani volcano-sedimentary sequence of Chotanagpur Granitic and Gneissic Complex (CGGC) of Eastern India

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The Bathani volcano-sedimentary sequence exposed in Nalanda and Gaya districts in Bihar exhibits a variety of rock types, viz., pillow basalt, phyllitic tuff, mafic pyroclastic rock, tuff, rhyolite, chert, banded iron formations, a minor band of garnet-mica schist and minor emplaced granitic bodies. Petrographic and geochemical analysis was done on representative basalt, granite and rhyolite samples from this unit. Inferences from data show that this

suite is a result of bimodal volcanism in an island arc setting with distinctive high LILE/HFSE ratios. The intermediate and felsic rocks of the suite appear to be differentiated products of the parental basaltic magma. These findings have great implications for the evolution of Indian plate during Proterozoic times.

41 Need of Sustainable Agriculture for better future development

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Key words - Soil properties; soil degradation; soil management; sustainable agriculture.

Indian economy is agrarian; hence the study of agricultural activity is essential. It is depend on several factors; but soil is an important element for agriculture. This paper discusses the effect on soil in pimpalgoan (Alwa) village. Such effect due to modern farming practices, particularly unplanned use of chemical fertilizer, pesticides and over irrigation. It outlines the problems which are beginning to become serious and suggest ways in which the situation might be improved. Soil management practices for sustainable agriculture are discussed and some suggestions are made on the future agriculture.

42 A Case Study on The Use of Recycled Materials - In Highway Construction

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As the world population grows, the amount and type of waste being generated. Many of wastes produced today will remain

in the environment for hundreds, perhaps thousands, of years. The creation of non-decaying waste materials, combined with growing population, has resulted in a waste disposal crisis. One solution to this crisis lies in recycling waste into useful products. Highway construction is a major sector in the construction industry, which requires a large quantity of materials to work upon.

The materials like plastics, polymers or fly ash are those wastes which became headache to destroy. Thus, consuming such materials in construction sector is an environment -friendly act. This article summarizes current research on those waste materials that have shown promise as a substitute for conventional materials. The use of plastics and polymer products in road construction has already been started in INDIA. Such acts in India were already been succeeding.

Current research on those waste materials that have shown promise as a substitute for conventional materials. The use of plastics and polymer products in road construction has already been started in INDIA. Such acts in India were already been succeeding.

43 CAPSULE CAMERA

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The aim of any new technology is to make products economical and wide range of applications. The current technologies have attained only a part of it, but the manufacturing technology is at macro level. The future lies in manufacturing product right from the molecular level. Research in this direction started way back in

eighties. At that time manufacturing at molecular and atomic level was laughed about. Due to advent of nano-technology we have realized it to a certain level. One such product manufactured is **PILL CAMERA**, which is used in the diagnosis and treatment of cancer, ulcer and anemia. Moreover the infections can also be detected in the very initial stage so as to adopt the preventive measures. It has made revolution in the field of medicine. This tiny capsule can pass through our body, without causing any harm. It takes pictures of our intestine, and the organs surrounding it and transmits the same to the receiver of the computer analysis of our digestive system. This helps in tracking any kind of disease related to digestive system. We had even discussed the drawbacks of PILL CAMERA and how these drawbacks can be overcome using Grain sized motor and bi-directional wireless telemetry capsule. Besides this we have reviewed the process of manufacturing products using nano-technology. Some other important applications are also discussed along with their potential impacts on various fields.

In short, our paper describes the manufacture, working, functioning and the uses of this new technology. We had discussed the near future improvements of this model, which would help in making this technology a no side effect one. We had stressed the concept of nano-technology, which has been the key behind the design and development of this model. This is perhaps expected to open a gateway for the dreams of scientists and researchers who aims at making the humans immortal.

44 Law of Convergence of masses

Krishna Mohan Agrawal

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Innovations are needed for our well being. Plate tectonics is wrong. 'Krishna Mohan's Law of Convergence of masses', defines all Evolution Newton's law of gravitation is wrong. Masses attract, if in relational motion.

Knowledge is for doing good to people. It is for creating sound minds in the country as well as world over, so that people can live happily and then may transmit that know how to the younger generation. Most knowledge is supposed to ultimately uplift the soul to the infinite.

Again energy may have a particular and different form presently, but the same energy can be transformed into several other forms. So knowledge of one kind may lead to several more know how as well, if properly tackled, otherwise not, howsoever hard one may try.

So a proper know how is the top priority of society for its prosperity. Therefore all education has to reform itself for the betterment of society, or to reform it. No education which in itself is incorrect can ever hope of doing any good to society, except creating a ground for itself, which may be for a few days only.

So continuous innovations are needed in our know how, for our own well being. This applies to our know how of 'Earth Sciences' as well. Presently we seem to be lacking a lot in this field. The present topic opens up a platform for such healthy debate and discussion, which has been the need for quite a long time.

I elaborate here in some aspects that need care and review. 'Krishna Mohan's Law of Convergence of masses', defines all Evolution in this hugely wide and wild 'Universe'.

99th Indian Science Congress
January 3-7, 2012, Bhubaneswar

VIII

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