

राष्ट्रीय भूभौतिकीय अनुसंधान संस्थान (वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्) समाचार पत्रिका



CSIR - NGRI

NEWS LETTER

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GOLDEN JUBILEE YEAR



NGRI (CSIR)
Oct. 2010 - Oct. 2011

FROM DIRECTOR'S DESK



This quarter assumes special importance as during this period the Institute's XII Five Year Science Plan took shape and concept notes were discussed at the CSIR Physical Sciences Cluster meeting. This was culmination of a long drawn process of internal discussions, consultations with the Research Council, sister labs and in some

cases, intense brainstorming involving representatives of many organizations, both Governmental and NGOs. Some of the XI Plan projects also enter their penultimate stage and not surprisingly, the entire scientific staff were engrossed in compilation of progress, achievements as well as shortfall in targets such that a shift in gear was perceivable as achievement of targets and deliverables was paramount.

This summer, we had nearly 200 postgraduate students from different universities and colleges across the country, who came by on a range of summer training programs and short duration projects and many scientists have devoted time and attention guiding and interacting with the young talent. It is hoped that for many students, this brief exposure to advanced research facilities and methods at the CSIR-NGRI was quite inspirational. This quarter has also been important for planning of major events marking the Golden Jubilee celebrations of the Institute (October 2010 to October 2011), especially the forthcoming International Conference on 'Super

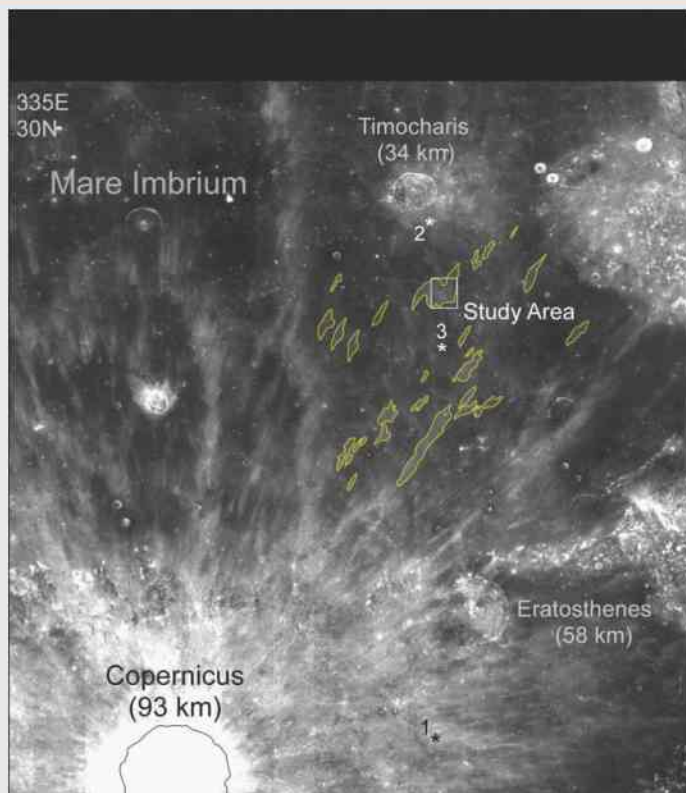
Continent Dynamics: India and Gondwana' organized jointly by CSIR-NGRI and the International Association of Gondwana Research (IAGR), Japan during August 26-28, 2011. Overall, the first half of this year has also been encouraging as over 70 SCI papers, many in high-impact International Journals, were published and about 20 are in the pipeline. I congratulate and thank all my colleagues who have been contributing positively to the pride of the Institute in many different ways.

AFEW IMPORTANT PUBLICATIONS

Chandrayaan-1 observation of distant secondary craters of Copernicus exhibiting central mound morphology: Evidence for low velocity clustered impacts on the Moon

Analysis of the Chandrayaan-1 Terrain Mapping Camera image of a 20 to 27 km area in the Mare Imbrium region revealed a cluster of thousands of fresh and buried impact craters in the size range of 20–1300 m.

A majority of the large fresh craters with diameter ranging from 160 to 1270 m exhibit near-circular mounds (30–335 m diameter and 10–40 m height) in the crater floor, and their size depends on the host crater size. The origin of this cluster of secondary craters may be traced to Copernicus crater, based on global lunar image and the analysis of Chandrayaan-1 Hyper Spectral Imager data. Our findings provide further evidence for secondary crater formation by low-velocity impact of a cloud of clustered fragments. The presence of central mounds can also distinguish the secondary craters from the primary craters and refine the chronology of lunar surface based on counting of small craters



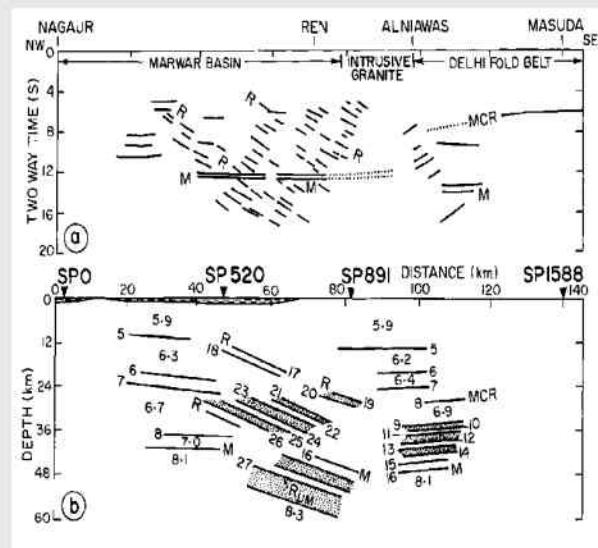
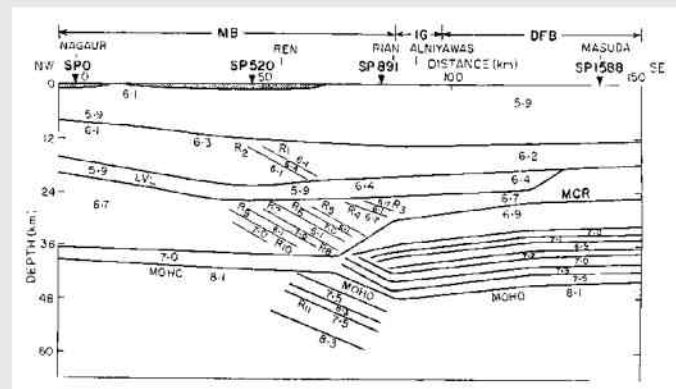
Clementine 750 nm albedo basemap V2 showing Copernicus crater and its ejecta ray deposits and the study area. The symbols (stars) show the locations of HySI spectral samples obtained from the Copernicus distal ray (1), Timocharis distal ejecta (2) and mare (3). (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

(Ref: P. Senthil Kumar in collaboration with scientists from ISRO& Physical Research Laboratory, Department of Space, Ahmedabad Journal: Planetary and Space Science)

Velocity modeling of a complex deep crustal structure across the Mesoproterozoic South Delhi Fold Belt, NW India, from joint interpretation of coincident seismic wide-angle and near-offset reflection data – An approach using unusual reflections in wide-angle records

An approach for joint interpretation of coincident seismic wide-angle and near-offset reflection datasets and modeling the unusual phases (high apparent velocity - limited lateral coherency reflections) of wide-angle records was proposed to delineate both velocity stratification and geometry of the deep crustal structures consistent with the near-offset reflection images. Processed and migrated near-offset reflection images reveal several steeply dipping isolated reflections on the western margin of the South Delhi Fold Belt (SDFB), NW India, interpreted as the South Delhi thrust fault. Coincident limited-aperture wide-angle records reveal bright unusual reflections, also found to be associated with

the same thrust fault. The reflectivity structural model from the near-offset dataset is used for modeling the travel times and amplitudes of the unusual reflections recognized in the wide-angle records by the Gaussian beam method. The unusual reflections are modeled as set of discrete reflectors representing local velocity variations imprinted on the background of deep crustal velocity structure. They are modeled and interpreted as reflections from the thrust fault, consistent with the near-offset reflection image. The lamellar structure revealed by short isolated dipping and the subhorizontal mid- to lower-crustal reflections, suggests crustal heterogeneities at scale lengths on the order of at least the Fresnel zone diameter.



A complex 2-D velocity model of the deep crust and uppermost mantle of the SDFB is derived for the first time. The crustal-scale south Delhi thrust fault on the western margin of the SDFB, delineated as the stack of reflectors, dipping 25°-30° SE, probably developed during the late Mesoproterozoic collisional episode, is related to the Delhi orogeny, contemporaneous with the formation of Rodinia. The study suggests that complex structural features developed during collisional episodes can survive longer periods than generally expected, depending on the accretionary

characteristics at the time of orogenic evolution. The 2-D velocity model further reveals significant variations of crustal seismic structure, with a relatively sharp and shallow Moho (at 39-40 km) in the Marwar Basin and a deeper Moho (at 45-47 km) underlying a 12-km-thick sub-horizontal lamella of high velocity (6.9-7.5 km/s) layers in the SDFB regions.

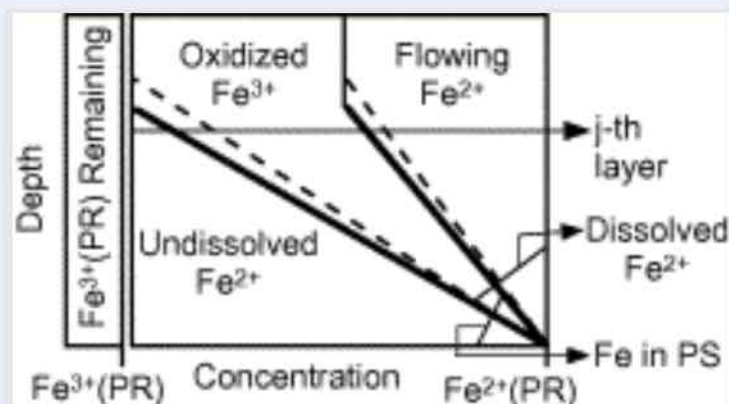
(Ref : Krishna, V.G and Vijaya Rao, V., 2011 J.Geophys. Res., 116)

Quantification of atmospheric oxygen levels during the Paleoproterozoic using paleosol compositions and iron oxidation kinetics

The increase in atmospheric oxygen during the Precambrian is a key to understanding the co-evolution of life and environment and has remained a debatable topic. Among various proxies for the estimation of atmospheric oxygen levels, paleosols and ancient weathering profiles, can provide a quantitative pattern of atmospheric oxygen increase during the Precambrian period of Earth history. The chemical compositions of paleosols were re-evaluated and a new method of applying Fe^{2+} oxidation kinetics to the Fe^{2+} and Fe^{3+} concentrations in paleosols to decipher the quantitative partial pressure of atmospheric oxygen (P_{O_2}) between 2.5 and 2.0 Ga was presented. The compaction factor (CF, the fraction of original thickness) was first estimated using the immobile elements such as Ti, Al and Zr on equal volume basis, which was then used to calculate retention fractions (M_R), a mass ratio of paleosol to parent rock, of redox-sensitive elements. The CF and Fe_R values were evaluated for factors such as homogeneity of immobile elements, erosion, and formation time of weathering. Fe_R increased gradually within the time window of ~2.5–2.1 Ga and remained close to 1.0 since ~2.1 Ga onwards. Mn_R also increased gradually similar to Fe_R but at a slower rate and near complete retention was observed ~1.85 Ga, suggesting an almost continuous increase in the oxidation of Fe^{2+} and Mn^{2+} in paleosols ranging in age between ~2.5 and ~1.9 Ga.

P_{O_2} variations during the Paleoproterozoic were modeled by applying Fe^{2+} oxidation kinetics to the Fe^{2+} and Fe^{3+} concentrations in paleosols, which led to derivation of Fe^{2+} oxidation term referred to as ψ . Possible changes in temperature and P_{CO_2} during this time window and their effects on resulting models of P_{O_2} evolution have been also considered. Four cases for the calculations of P_{O_2} variations between 2.5 and 2.0 Ga were assumed: no change in either temperature or P_{CO_2} , long-term change in only P_{CO_2} , long-term changes in both temperature and P_{CO_2} , and short-term fluctuations of both temperature and P_{CO_2} during the possible, multiple global-scale glaciations.

The calculations indicate that P_{O_2} increased gradually, linearly on the logarithmic scale, from $< \sim 10^{-6}$ to $> \sim 10^{-3}$ atm between 2.5 and 2.0 Ga. The calculations show that the P_{O_2} levels would have fluctuated significantly, if intense, global glaciation(s) followed by period(s) of high temperature occurred during the Paleoproterozoic. This gradual rise model proposes a distinct, quantitative pattern for the first atmospheric oxygen rise with important implications for the evolution of life.



Schematic diagram of the fate of Fe^{2+} and Fe^{3+} initially contained in primary minerals. $\text{Fe}^{2+}(\text{PR})$ and $\text{Fe}^{3+}(\text{PR})$ are the concentrations of Fe^{2+} and Fe^{3+} in a parent rock, respectively

(Ref: Takashi Murakami^a, Bulusu Sreenivas, Subrata Das Sharma and Hirokazu Sugimori^a Journal: *Geochimica et Cosmochimica Acta*)

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Seismic quality factors across a bottom simulating reflector in the Makran Accretionary Prism, Arabian Sea

The hydrate-bearing sediments above the bottom simulating reflector (BSR) are associated with low attenuation or high quality factor (Q), whereas underlying gas-bearing sediments exhibit high attenuation. Hence, estimation of Q can be important for qualifying whether a BSR is related to gas hydrates and free-gas. This property is also useful for identifying gas hydrates where detection of BSR is dubious. Here, the interval Q for three submarine sedimentary layers bounded by seafloor, BSR, one reflector above and another reflector below the BSR at three locations with moderate, strong and no BSR along a seismic line in the Makran accretionary prism, Arabian Sea were calculated for studying attenuation (Q^{-1}) characteristics of sediments. Interval Q for hydrate-bearing sediments (layer B) above the BSR are estimated as 191 ± 11 , 223 ± 12 , and 117 ± 5 , whereas interval Q for the underlying gas-bearing sediments (layer C) are calculated as 112 ± 7 , 107 ± 8 and 124 ± 11 at moderate, strong and no BSR locations

respectively. The large variation in Q is observed at strong BSR. Thus, Q can be used for ascertaining whether the observed BSR is due to gas hydrates, and for identifying gas hydrates at places where detection of BSR is rather doubtful. Interval Q of 98 ± 4 , 108 ± 5 , and 102 ± 5 , respectively, at moderate, strong and no BSR locations for the layer immediately beneath the seafloor (layer A) show almost uniform attenuation.

Thus, besides characterizing the sediments, the estimated Q can be used for designing an inverse Q filter to compensate the effects of attenuation for producing improved structural images of shallow submarine sediments including the BSR and other reflectors.

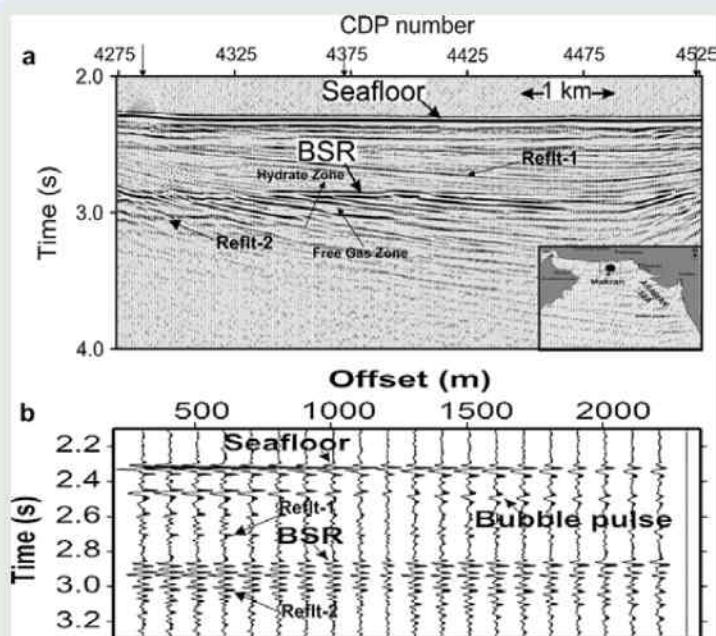


Fig. (a). Seismic stack section along a north-south seismic line (inset shows the study area (box) in the Makran accretionary prism). Amplitude spectra have been calculated around four reflectors: seafloor, reflect-1, BSR and reflect-2. (b) NMO corrected CDP gather at CDP 4372, showing the reflections at various offsets from the said four reflectors.

(Ref: Kalachand Sain, Anoop Kumar Singh, Marine and Petroleum Geology doi:10.1016/j.marpetgeo.2011.03.013)

High-resolution carbon and oxygen isotope records from a scleractinian (*Porites*) coral of Lakshadweep Archipelago reveal variations in monsoon induced changes in surface seawater characteristics

A 17-year-long $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ record from a scleractinian coral (*Porites* spp.) of Bangaram island (Lakshadweep Archipelago) is based on a nearly-monthly sample interval. This live coral head of *Porites* spp. was recovered from the lagoon of Bangaram (Lakshadweep) island at ~20m water-depth. The skeletal $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ values varied

approximately in phase and exhibit a positive relationship with each other. High-density (monsoon) bands are characterized by enriched $\delta^{18}\text{O}$ values and low-density (non-monsoon) bands by depleted $\delta^{18}\text{O}$ values. Coral $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ primarily reflects local oceanographic and climatic variability. The high-density bands were formed during the southwest monsoon (June–September) because of increased turbidity and cloud cover, whereas low-density bands were deposited during the non-monsoon months (October–May). Temporal changes in coral-derived sea surface temperature (SST) show a good agreement with instrumental SST record. The $\delta^{18}\text{O}$ values in monsoon and non-monsoon bands are mainly due to the sea surface temperature (SST) changes, controlled by monsoon-induced upwelling and insolation changes. Coral-derived SST values clearly show warming events during summer 1993 and 1998. Spectral analysis of $\delta^{18}\text{O}$ data reveals a tele connection between the local SST and tropical Pacific climate variability. Enriched $\delta^{18}\text{O}$ values for the monsoon months of 1984, 1985, 1993 and 1997 are probably indicative of cooler surface water due to the stronger upwelling at the studied location.

Generally, higher $\delta^{13}\text{C}$ values correlate with enriched $\delta^{18}\text{O}$ values of the monsoon bands. This increase in $\delta^{13}\text{C}$ during the southwest monsoon months is attributed to a decrease in endosymbiotic photosynthesis. Alternatively, an increase in biological production, due to monsoon-induced upwelling, may have resulted in the $\delta^{13}\text{C}$ enrichment of dissolved inorganic carbon (DIC) in surface waters.

However, other possibilities, such as higher $\delta^{13}\text{C}$ values due to coral mass-spawning events during monsoon times cannot be ruled out. A progressive decrease of ~0.5% in $\delta^{13}\text{C}$ from 1985 to 2001 may be due to the changes in photosynthesis and/or changing food habits from autotrophy to heterotrophy as the coral grew in size. Thus, the monthly-scale $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ records for 1985–2001 A.D. from a scleractinian coral at Bangaram Island reveal variations in monsoon-induced changes in surface seawater characteristics.



X-radiograph (positive) of *Porites* spp. from Bangaram island. Dark (high-density) and light (low-density) bands represent monsoon and non-monsoon times respectively. A pair of dark and light band represents one year. The vertical line shows sampling transect

(Ref: S. Masood Ahmad et al journal: Quaternary International vol 284, pp 211-216)

Hydrochemical characteristic of coastal aquifer from Tuticorin, Tamil Nadu, India

This article deals with a systematic hydrochemical study carried out in coastal aquifers, Tuticorin, Tamil Nadu, to assess groundwater quality. A total of 29 groundwater samples were collected and analyzed. Results showed that total dissolved solids (TDS), sodium (Na^+), magnesium (Mg^{2+}), chloride (Cl^-), and sulfate (SO_4^{2-}) significantly damaged groundwater systems. The degree of salinization due to seawater mixing in a well or a given area could be indicated by an increase in nearly all major cations and anions. Toxic elements (i.e., Pb and As) were higher than the maximum permissible limits of drinking water. Cross plot of $\text{HCO}_3^- / \text{Cl}^-$ (molar ratios) versus TDS indicated that about 62% of the analyzed samples were saline. Factor analysis showed that groundwaters, affected by seawater intrusion/industrial activity, were separated from the clusters. An attempt was made to identify the hydrochemical processes that accompany current intrusion of seawater using ionic changes. It was estimated that the mixing rate of seawater intrusion was about 5.81% during April 2007. An index, called 'Seawater Mixing Index' (SMI), was also adopted and its value was $\text{SMI} > 1.18$ with $\text{EC} > 3,000 \mu\text{S}/\text{cm}$ about 62% of the sampled waters, were saline. Further, a few trace elements (i.e., Sr, B, and Li) were used as indicators for responding to the change in fresh to saline groundwater environments in coastal aquifers.

(Ref: Nepal C. Mondal, Vijay P. Singh, Somvir Singh, and V.S.Singh, Journal: Environ Monit Assess. 175(1-4) pp 531-550.)

IMPORTANT EVENTS

Birthday celebrations of Dr. B. R. Ambedkar

The 121st birthday of Dr. B. R. Ambedkar was celebrated at NGRI on 20th May 2011. Prof. G. Nanchariah, Professor of Economics and former Vice Chancellor, Ambedkar University, Lucknow, was

the chief guest and delivered the memorial lecture with a very appropriate title befitting the occasion "Dr. Ambedkar: Vision to Modern India with the influence of socio economic factors".

Dr. Nanchariah explained how the economics and caste structure are interrelated in India and highlighted Dr. B. R. Ambedkar's vision to the modern Indian society. Dr. Y. J. Bhaskar Rao, Acting Director touched upon the activities and training facilities being provided to SC/ST employees at NGRI. The function started with the welcome address by Dr. P. V. Sunder Raju, Scientist and ended with vote of thanks by Mr. Satish Chandrapuri, scientist.

Technology Day Celebrations

Three Laboratories of CSIR family at Hyderabad, NGRI, IICT & CCMB joined together to celebrate the National Technology Day at IICT on 11th May, 2011 in collaboration with Andhra Pradesh Academy of Sciences, Hyderabad. Padmashri Dr. Baldev Raj,



Director, Indira Gandhi Centre for Atomic Research, Chennai was the Chief Guest and delivered the talk entitled "Energy, Ethics and Equity" which is quite relevant in the present day scenario. During his talk, Dr. Baldev Raj emphasized the importance of sensitizing the stakeholders and future young leaders on emerging challenges and opportunities in the energy sector that are linked with societal responsibilities and path ways ahead in meeting these obligations. The talk focused on the various facets of Energy such as Technology Facet, Economic and Cultural Facet, Ecological Facet and Business Facet which play a vital role in the Energy Cycle.

Dr. Baldev Raj gave an account of current levels of annual species extinction rate, concentration of CO_2 and nitrogen which have far exceeded the safe limits while change in land use, fresh water use and ocean acidification are likely to approach towards dangerous limits by mid century. He mentioned that the world energy requirement would increase two-fold by 2050 and three-fold by 2100. The CO_2 emissions due to coal consumption for power generation is projected to be



around 850 MT by 2025 which will be a threat for the environment. He opined that solar energy is one of the most promising carbon free technology for future but the energy storage options should develop for its effective utilization.

The world would be facing twin energy related threats that of not having adequate, secure and accessible supplier of energy at affordable costs and that of environmental harm caused by consuming large quantities of fuels. There is a need to propagate the concept of sustainable economic development to overcome the energy crisis and to mitigate the adverse impact on environment and society by the aggressive pursuit of conventional and classic energy options in a manner that foster Equity and Ethics in wealth creation and human style.

Dr. Baldev Raj concluded the talk saying that Energy, Water, Health, Land and Food are to be considered in a comprehensive and interlinked fashion for sustainable options with better quality of life to all the citizens of the planet.

Distinguished Lecture by Dr. J. S. Yadav

In celebrating the International Year of Chemistry,



CSIR-NGRI organized an Invited Lecture by Dr. J. S. Yadav, Director, CSIR-IICT, Hyderabad, who spoke on the Role of Chemistry in the sustainable development of a greener planet, where the needs of the present and future generations would be met not compromising on the health of the environment. Dr. Yadav emphasized that the outstanding problems with regard to our demands for energy, water, food and environmental sustainability can be appropriately dealt with, directly or indirectly, through R & D in chemistry.

'Green chemistry' according to Dr. Yadav is a multi-disciplinary study involving fundamental sciences, business, law and engineering. The benefits achieved through its use could stimulate a greener

technological revolution. An enthusiast of greener processes, Dr. Yadav cited several examples of traditional organic synthesis and classical processes such as tanning of leather etc, which have been transformed to safer and environment friendly processes through new concepts and practises. He explained the significance of a new class of solvents, including aqueous ionic solvents in advanced synthetic, organic and industrial chemistry affecting such eco-friendly transformations. He showed how water can be used in several enzymatic and metal catalyst reactions to achieve greener synthesis. In developing countries like India, where synthetic reagents and solvents involve high cost, delays in delivery, Dr. Yadav gave interesting ideas on use of cheaper solvents from new sources and approaches. Differentiating between ionic liquids and molecular liquids, Dr. Yadav explained the advantages of the former for eco-friendly synthesis and catalysis. He also spoke on the application of Atom Economy, which utilizes laser catalytic steps. Discussing the importance of super critical fluids, Dr. Yadav encouraged researchers to adopt them as part of a new strategy in processes such as hydrogenation, etc. Through the use of agrochemicals such as pheromones and semio-chemicals for alternative pest control, Dr. Yadav explained some new strategies for cleaner and healthier agro-produce and towards biodegradable, non-toxic products that are gaining increasing acceptance. Dr. Yadav gave an outstanding example of green technology wherein through biotechnology based degumming process, the CSIR-IICT paved the way for production of rice bran oil, where all the nutritional components are retained, but production cost reduced. Finally, it was a very inspiring talk not only educating the CSIR-NGRI audience on greener chemistry but also bringing to light the significant contributions CSIR-IICT was making in this vital field of research.

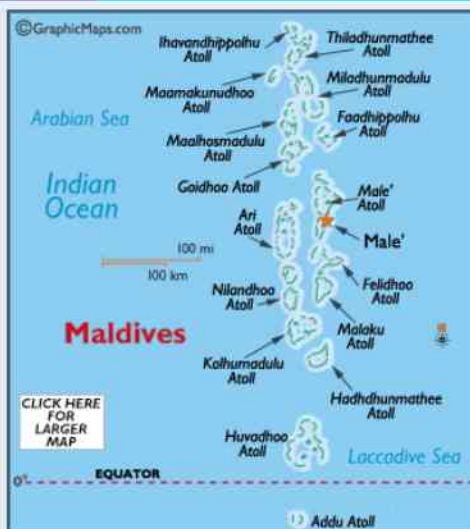
Commissioning a new low latitude Digital Magnetic Observatory at GAN Island- Addu Atoll, Maldives.

A new Digital Magnetic Observatory has been set up and put into operation at Gan Island, Addu Atoll south of Maldives (Lat: 0° 41.673'S & Long: 73° 09. 236'E) by the Maldives Meteorological Services, Maldives, Federal Institute of Technology (ETH), Zurich and National Geophysical Research Institute, Hyderabad during 10th to 18th April 2011, under a tripartite collaboration.

The significance of this observatory lies in its location, south of the Equator, in a region of the world where no magnetic variation data have been recorded. Mr. K. Chandra Sekhar Rao, Sr. Technical Officer from



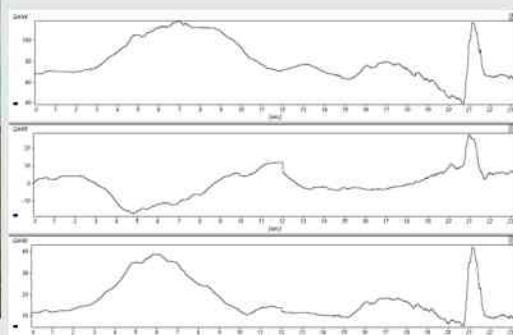
Map of Maldives



CLICK HERE FOR LARGER MAP



Digital Magnetic Observatory at Gan Island Maldives



Gan-Digital Magnetogram_29-04-2011

and adjacent gold-hosting terranes of the Eastern and Western Dharwar craton and reliable geochronology of other significant gold deposits. A tectonic synthesis of existing and new data as a template for future research and to underpin and revitalise future gold exploration activity is envisaged. Apart from NGRI, Pondicherry University and Curtin University from Australia are involved in this program.

As a part of the proposed project, a Workshop was held from 12th to 14th February, 2011 to assess the present status on the project and to chalk out the future plan of action. Prof. Neal Mc. Naughton, Project Leader along with Dr.

Ayyasami, Dy. DG, GSI, Hyderabad, Dr. V. N. Vasudev, Geomysore, Bangalore, Dr. Y. J. Bhaskar Rao, Acting Director, CSIR-NGRI, officers from Hutti Gold Mines, and other Scientists from NGRI participated in the discussions.

the Magnetic Observatory of NGRI was invited to conduct the series of Declination & Inclination (DI) measurements with modern DI-Fluxgate magnetometer for fixing baseline values for conversion of the continuous magnetic variation data to its absolute one, for this new GAN Magnetic Observatory, Maldives. He also participated in the Sun dial observations for fixing Azimuth Mark correction which is very important in Declination measurements at each and every magnetic observatory as a basic principle for the Global INTERMAGNET community requirements.

The GAN-Digital Magnetic Observatory started recording data continuously from 17th April, 2011. The data is available at NGRI through dedicated links for further processing and analysis. Colleagues from the Maldives Meteorological Services will also undergo training at our Institute, periodically till they gain the required expertise to maintain international standards of data.

Launching of AISRF Project

An international collaborative program entitled **"Exposing the gold potential of the Neoproterozoic Himalaya of the Dharwar Craton in southern India"** has been approved under the scheme of Indo-Australian Strategic Fund Scheme. The project is aimed at understanding the time and space relationship between the Closepet Granite batholith



PATENT GRANTED

A US patent "Method for Computing an Exact Impulse Response of a plane Acoustic Reflector at zero offset due to a point Acoustic Source" was granted vide Patent No. US 7,940,601 to Dr. S. K. Ghosh, Chief Scientist.

LECTURES DELIVERED BY DISTINGUISHED VISITORS

Date	Name of the Visitor	Title of the Talk
8 th April, 2011	Prof. Enver Ablya Moscow State University, Moscow	New Paradigm for Petroleum Exploration – Fluid-dynamic concept
4 th May, 2011	Padma Shri Dr. Chaitanyamay Ganguly Indian Institute of Chemical Engineers Hyderabad Regional Centre	Post Fukushima Nuclear Strategies
6 th May, 2011	Dr. Conard Lindholm	NORSAR Research : Verification earthquakes petroleum
6 th May, 2011	Dr. Volker Oye	Microseismic Research at NORSAR - Analysis of Micro earthquakes in Hydrocarbon Reservoirs, Mines, the San Andreas Fault Observatory at Depth, Enhanced Geothermal Systems and a Creeping Rock Slope at a Norwegian Ford
22 nd June, 2011	Prof. Aksel Walloe Hansen University of Copenhagen, Denmark	Effect of human energy Demand on Climate : Discussion

IN-HOUSE TALKS

3 rd June, 2011	Dr. N. Purnachandra Rao Sr. Principal Scientist	Preparatory studies towards scientific deep drilling program in the Koyna-Warna Region
24 th June, 2011	Dr. R. N. Singh, Emeritus Scientist	Flash heating on earthquake ruptures

SUPERANNUATED STAFF MEMBERS

- | | |
|-----------------------------------------|--------------------------------------------|
| 1. Dr. S. Nirmal Charan, Scientist | 8. Mr. N. Ravi Kumar, Scientist |
| 2. Dr. T. R. K. Chetty, Scientist | 9. Mr. M. Yadaiah, Jr. Sec. Gaurd |
| 3. Mr. M. Shankeraiah, Tech. Officer | 10. Mr. N. Nagendra, Sr. Technician(2) |
| 4. Dr. V. Subramanya Sarma, Scientist | 11. Mr. Yunusullah Khan, Sr. Technician(2) |
| 5. Dr. H. V. Ram Babu, Scientist | 12. Mr. A. Nageswara Rao, Tech. Officer |
| 6. Mr. M. V. B. M. Sarma, Tech. Officer | 13. Mr. CH. Srinivasa Rao, COA |
| 7. Mr. M. Ratnam, Sec. Gaurd(ACP) | |

FORTHCOMING EVENTS

IAGR Annual Convention-2011 and 8th International Symposium on **Supercontinent Dynamics: India and Gondwana**, Organized by CSIR - NGRI, India and International Association of Gondwana Research (IAGR), Japan during August 26 - 28, 2011

FOR DETAILS CONTACT:
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Web:- <http://www.ngri.org.in/htmlfiles/forthcomingevents.html> (registration & details)

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