

Timescales of Melting in Hot Orogens: 'Inside-out' zircons from the Kerala Khondalite Belt

The Khondalite belt of southern Kerala represents part of an extensive late Neoproterozoic sedimentary basin that formed prior to the final amalgamation of Gondwana which underwent high-temperature metamorphism during that amalgamation. Peak metamorphic temperatures varied across the Kerala Khondalite Belt and reached ultra high temperature conditions indicated for those granulites from the north-eastern sub area near the Achankovil Shear Zone. The recognition of spinel + quartz in grain contact and high temperature mesoperthites in metapelitic granulites of the KKB has confirmed that ultrahigh temperatures were attained during extreme crustal metamorphism associated with Gondwana amalgamation and possibly orogenic collapse in the Cambrian. Various reaction textures involving the breakdown of garnet with sillimanite and formation of cordierite-bearing symplectites suggest that the KKB granulites underwent isothermal decompression during the later stages of their exhumation, consistent with models for the metamorphism that invoke extensional collapse following crustal thickening and burial of the high-heat production KKB sedimentary protoliths. U-Th-Pb analyses of monazites from Chittikkara quarry shows that relict monazite cores shielded by garnets are as old as 1700 Ma and event(s) during late Neoproterozoic-Cambrian, resulted in the formation of Pan-African mantles to these monazite cores. In-situ SIMS REE and trace element analysis of garnets and zircons from leucosomes in the Kerala Khondalite Belt (KKB) shows that these minerals grew together in the studied melts. The distribution of REE between zircon and garnet in these leucosomes, $D_{REE}(zrc/grt)$, correlates very well with experimental data (fig. 1). Monazite in these leucosomes overgrows and includes the zircon, and so has grown in a chemical environment already depleted in HREE. An integrated monazite-zircon study of leucosomes and migmatites from the highest-T portion of the Kerala Khondalite Belt of

Continued in page 2



Shri. Oommen Chandy, Hon'ble Chief Minister of Kerala inaugurates the 'Ocean State Forecast and Fishery Information System for Kerala at Vizhinjam, Thiruvananthapuram. Dr. Satheesh C. Shenoi, Director, INCOIS, Shri. Shashi Tharoor, M.P, Smt. Jameela Prakasam M.L.A, Smt. K. Chandrika, Mayor, Thiruvananthapuram Corporation, Smt. Gladis Alex, Councillor Vizhinjam, Dr. N. P. Kurian, Director, CESS are also seen.

Chief Minister inaugurated the Ocean State Forecast System for Kerala

The first phase of the Ocean State Forecast System for the Kerala coast jointly established by Indian National Centre for Ocean Information Services (INCOIS), Hyderabad and CESS at Vizhinjam harbour, near Thiruvananthapuram was formally inaugurated by Shri Oommen Chandy, Hon'ble Chief Minister of Kerala on 16th of July 2011. The Electronic Display Board facility set up at Vizhinjam harbour for the dissemination of the sea state forecast information to the local fishermen community was unveiled by Dr. Shashi Tharoor, Member of Parliament from Thiruvananthapuram. Smt. Jameela Prakasam, Member Legislative Assembly, Kerala presided over the function. Smt. K. Chandrika, Mayor, Corporation of Thiruvananthapuram, Smt. Remani P Nair, President, District Panchayat, Smt. Galdis Alex, Councilor, Vizhinjam and Dr. K. K. Ramachandran, Member Secretary, Kerala State Council for Science, Technology and Environment also spoke on the occasion. Dr. N. P. Kurian, Director CESS delivered the welcome speech and Dr. Satheesh C Shenoi, Director,

INCOIS introduced the Ocean State Forecast and Fishery Information System. Dr. T. M. Balakrishnan, Head, Information Services Group, INCOIS proposed the vote of thanks. The information system issues real time details on tides, wind, waves, ocean current, etc for the use of the coastal community, Coast Guards, National Hydrographic Office etc. Information on Potential Fishing Zones is disseminated through electronic sign boards installed at designated points. The data is processed at INCOIS and bulletins and forecast warnings are issued on weather conditions, storms etc. through their website.

As part of this project another coastal observation station and electronic display board will be established in Kozhikode soon. The programme will be further expanded and establish more coastal observation stations along the Kerala coast during the 12th Plan period.

A workshop was also organized after the inaugural function to educate the coastal community about the use of sea state forecast system.

Director Speaks



India is bestowed with a wide variety of valuable mineral resources. Among them, the beach placer deposits have a unique position because of their high export demand and industrial significance. Placer or heavy minerals (specific gravity > 2.9) get concentrated in various pockets of beach as well as inland, along active and submerged channels. In fact, Kerala hosts some of the best and largest heavy mineral placer concentrations of the world. Therefore, CESS since its inception, has carried out a number of scientific projects to understand their concentration mechanism, economic potential, mineral chemistry and provenance. The chief minerals of these reserves are ilmenite, rutile, zircon, monazite and garnet.

Recently, the attention of placer-geologists have turned into value addition of these minerals because of significant high-end applications, such as in aircraft, space and nuclear industries. In this context, a couple of studies carried out by this Centre have brought out interesting conclusions. The bulk and complex beach deposits bear specific grades of individual minerals, which belong to either various rock types or formed due to characteristic depositional environments. The inherent physico-chemical heterogeneity of minerals helps in the separation of different grades from the raw ore. The intrinsic property of grades could be grain size, magnetism, specific gravity, electric conductance or radioactivity. Since each separated grade has compositional heterogeneity, they can be beneficiated to produce specific-quality end products.

In the case of ilmenite and zircon, crystals relatively free of intergrowths decide their economical value. Earlier, ilmenite was essentially used only for the manufacture of pigments and paints. However, the demand of titanium and titanium based products coupled with the scarcity of natural rutile has dramatically increased the scope of this mineral. Similarly, zircon that has been conventionally used in refractories and as opacifier in tiles and sanitary ware is largely being used for extraction of zirconium, hafnium and several zirconium based products. Further, the application of garnet in various types of abrasive and the use of monazite in thorium-based nuclear energy plants underline the requirement of detailed characterization of all placer minerals in terms of their physico-chemical properties. Premium prices can also be charged to the high-quality raw grades, instead of exporting mineral concentrates in composite form.

Sorting of ilmenite and zircons of Kerala beach placers has confirmed that industrially viable grades exist with respect to magnetism for ilmenite and specific gravity and texture for zircon. Mineral processing at laboratory scales, based on these two minerals, have confirmed that an initial grading followed by beneficiation adds significant economic value to our limited coastal mineral resources. Variations of mineral grades in terms of micromorphology, colour, shape, major, minor and trace elements etc. have been documented. Parameters like Fe/Ti ratios, Mg-Mn contents, Zr/Hf ratios and light rare earth elements content were found to be the key chemical indicators supporting the above inferences. Studies on monazite are being taken up for similar evaluation.

As various mineral processing units exist in southern India under state, central and private ownerships, additional research intervention is warranted to take care of the interests of all stakeholders in this important sector. Our sophisticated analytical tools and association with various industrial units, universities and institutes in the region are expected to significantly enhance our knowledge on this topic.

Dr. N. P. Kurian

Continued from page 1

southern India (P-T: 7 kbar, 930°C) has demonstrated that high-percentage melting (>20 vol%), leucogranitic melt migration, and interaction of melt with host rocks consequent on melt ponding and crystallisation occurred over a prolonged time interval of at least 25 Ma, from at least ca. 560 Ma to 535 Ma. Here we report results from one leucosome-rich migmatite (KUL), in which zircons preserve a remarkable textural record of growth, dissolution and modification. We have applied REE analysis to evaluate the growth behaviour of these unusual zircons and devised our strategy for the subsequent zircon U-Pb isotopic dating.

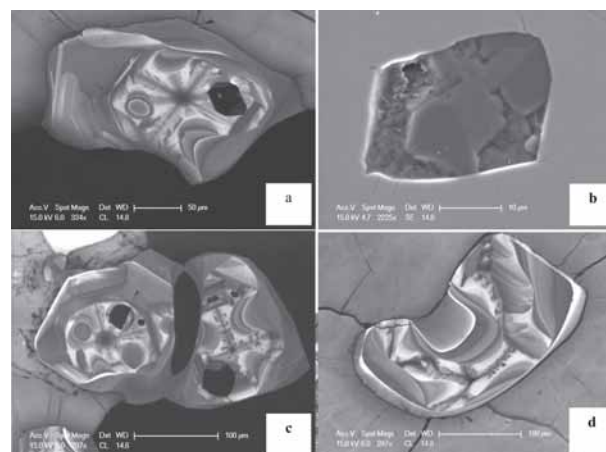


Fig. 1 CL (a, c, d) and SEI (b) images of zircon features in KUL. (a) shows the typical internal features of a zircon with a 'complete' core region and outer planar-zoned material, with some invasion of one sector by lobe of modified zircon, circular zircon in another sector, and a preserved former melt inclusion in another. (b) shows a nanogranite inclusion. (c) shows two grains welded together along a dissolution-reprecipitation front. (d) shows a composite of possibly 3 zircons (indicated by the trellis features) highly modified by invasive lobes.

KUL zircons preserve complex cores, planar-sector to 'firtree' and oscillatory zoned euhedral rim domains ('bright planar' and 'dark planar'), and darker-CL rinds and invasive lobes (Fig. 1a). Complete 'cores' have square cross sections, divided into sectors by axial zones of dark-CL zircon that form trellis and feathery structures. Intervening bright-CL sectors contain either an inclusion of quartz or finely crystalline quartzofeldspathic material (Fig. 1b), or a circular to elliptical domain of markedly zoned zircon (Fig. 1a, 1c) that may be continuous with the lobes of invasive darker-CL zircon. Fig. 1c shows a composite zircon grain pair, in which one complex core has later been disrupted and replaced by a truncating lobe or domain of dark-CL zircon. The other complex core is mostly intact, with axial trellis zones, 1 inclusion, 2 circular oscillatory domains and one invasive lobe.

Structurally simpler planar-sector zoned zircon surrounds the complex cores. Two planar-sector zone types occur: those that are brighter in CL ('bright planar') and moderately oscillatory, and those that are darker in CL ('dark planar') and weakly oscillatory. Both 'core' and 'planar-sector' type zircon domains are variably truncated, modified or replaced by lobate, curvilinear, 'swirling' and cusped zircon domains ('lobate zircon') that also form outermost rinds (Fig. 1d). This lobate zir-

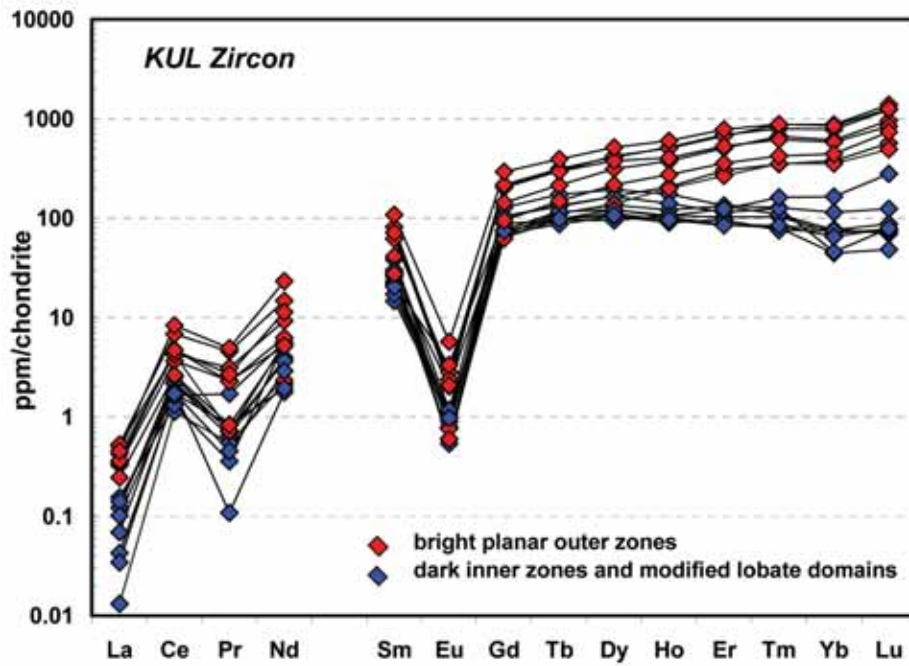


Fig. 2. Zircon Rare Earth Element patterns. Bright-CL planar-sector and axial zircon domains are high and fractionated in HREE ($Yb_n/Gd_n = 5.7 - 2.7$; $D_{Yn} = 140-520$) compared with darker-CL planar, interior lobate and modified domains, which have flat HREE ($Yb_n/Gd_n = 0.9$; $D_{Yn} = 130$). Garnet patterns (not shown) are characterised by flat HREE ($Yb_n/Gd_n = 1.2$) at $D_{Yn} = 165$.

con, whether on rims or invasive into complex cores, represents the final phase of KUL zircon formation and modification.

The timing relationships between the spectacular complex core zircon domains and the planar-sector euhedral zircon zones are ambiguous. The complex cores show internal modifications that appear to truncate or interact with the most 'internal' of the planar-sector zones. This, coupled with the common observation of inclusions with negative crystal shapes, similar in

mineralogy and micro texture to 'nanogranite', suggests that the zircons may have grown as 'hopper' crystals in which the planar-sector euhedral rims grew faster than cores. In this 'inside-out' growth model zircon cores would have contained tubes of melt, filled by late-stage zircon growth. This model is evaluated using the REE results, and will be tested further using zircon U-Pb dating

REE and other selected trace elements within zircons and garnets were determined using the EMMAC CAMECA ims-4f ion microprobe (University of Edinburgh). Analytical conditions and correction procedures follow those of Harley & Kelly. Analyses were conducted using a 6 nA O⁻ primary beam. Secondary ions were extracted at 4500V and measured at a 120eV high-energy offset for zircon and 75eV energy offset for garnet. Trace element abundances were calibrated against the NIST-610 glass standard and ion yields corrected by reference to zircon SL1 and garnet DDI garnet.

Trace element chemistry allows distinction of the texturally-defined bright-CL planar zircon from the dark-CL, weakly zoned but undisturbed zircon cores, elliptical / circular modified core zircon, and lobate invasive zircon. The former shows elevated and fractionated HREE (red diamonds in Fig. 2), moderate $Th/U > 0.3$ and low $U/Yb = 2.8$. The latter types, grouped together on Fig. 2, have moderate and flat HREE, $Th/U < 0.3$, and high U/Yb (20-64). Details of these zircon chemistries and the measured garnet REE features are provided in the captions to Fig. 2 and Fig. 3.

The REE data indicate that only the darker-zoned and modified zircon, formed in the presence of melt, approached equilibrium with host-rock garnet. Initial zircon crystallisation from melt, producing 'hopper' type zircon with outer planar-sector zoning, occurred in a melt-rich open system prior to interaction of the melt with garnet. Garnet-melt interaction later accompanied the continued precipitation of zircon as modified lobes and tubes filling melt-bearing zircon grains as the melt crystallised. The age of this phase of melt crystallisation, interaction and garnet-zircon-melt equilibration should be at least 535 Ma, the age obtained from the main monazite population in KUL.

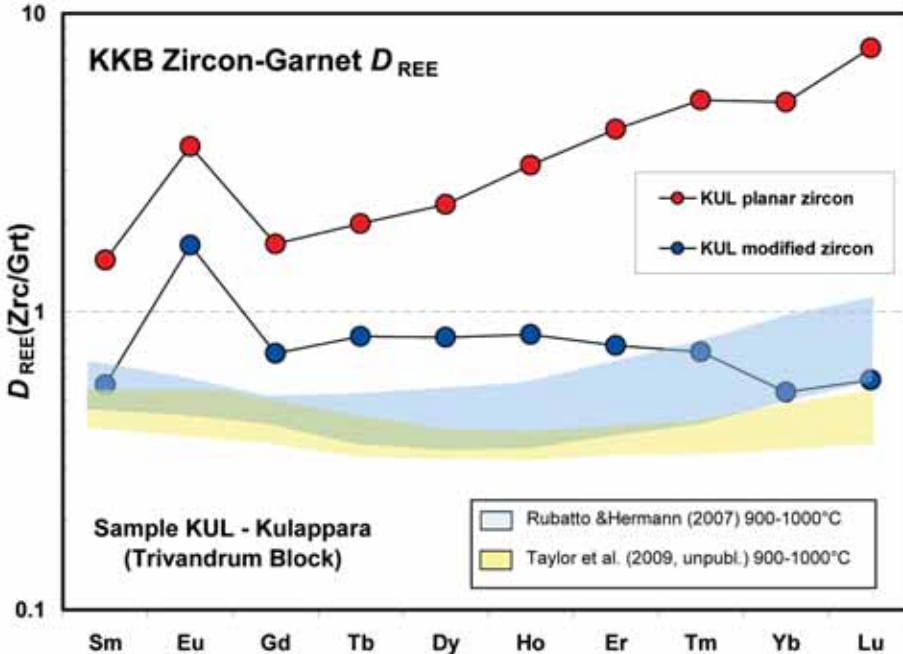


Fig. 3. Distribution of MREE-HREE between the two zircon textural types and garnet in KUL. Pairing of the planar-sector zoned zircon with garnet yields D_{HREE} that range from 1.7 at Gd to 5.1 at Yb, far removed from equilibrium. Pairing of the dark-zoned and modified zircon with garnet yields D_{HREE} that overlap with the preferred empirical equilibrium values at 850-1000°C (Harley et al., 2007) and lie within range of experimental D_{REE} results (Rubatto & Hermann 2007). KUL zircon has undergone its late-stage crystallisation and modification in the presence of and in close equilibrium with garnet

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Papers published in Journals

Anoop Krishnan K, Sreejalekshmi, K G, Baiju R S (2011) Nickel(II) adsorption onto biomass based activated carbon obtained from sugarcane bagasse pith. *Bioresource Technology*, DOI:10.1016/j.biortech.2011.08.069.

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Udayakumar P, Jean Jose J, Rajesh B R and Narendra Babu K (2011) 'Seasonal dynamics of dissolved metals in surface coastal waters of SW India, *Bulletin of Environmental Contamination and Toxicology*, DOI:10.1007/S128-011-0402-0.

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Padmalal D, Remya S I, Jissy Jyothi S, Baijulal B, Narendra Babu K (2011) Water quality and dissolved inorganic fluxes of N, P, SO_4 and K of a small catchment river in the Southwestern Coast of India, *Environmental Monitoring and Assessment*, DOI:10.1007/s10661-011-2059-X.

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Jayanthi J L, Nisha Unni, Manju S, Philip E K, Jeemon P, Baiju KV, Beena V T and Subhash N (2011) Diffuse reflectance spectroscopy: Diagnostic accuracy of non-invasive screening technique for early detection of malignant changes in the oral cavity, *British Medical Journal (BMJ Open)*, DOI: 10.1136/bmjopen-2011-000071.

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Vishnu Mohan S, Anooja S, Baiju R S and Padmalal D (2011) Indication of sea level changes on sediment dispersal pattern of a tropical river and estuary, SW, India. *Proc. 24th Annual Convention of Indian Institute of Geo-*

morphologists and Nat. Conf. on Coastal Dynamics and Geomorphology, Anna University, Chennai, pp. 40-41.

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Rupananda Mallia and Subhash N (2010) Photodiagnosis of Oral Malignancy-Basic, Translational and Clinical, Lap Lambert Academic Publishing GmbH, Germany, 175p.

Papers Presented in Conferences

Jayanthi J L, Manju S and Subhash N presented a paper entitled 'Diffuse Reflectance imaging: A new perspective in Oral Cancer Diagnosis' in the 23rd Kerala Science Congress 2011.

Raji S Nair, Aparna G Nair and Subhash N presented a paper entitled 'Integration of a multispectral imaging system consisting of EMCCD camera and liquid crystal tunable filter using labview' in the 23rd Kerala Science Congress 2011.

Prasanth C S and Subhash N presented a paper entitled 'Effective Antimicrobial Photodynamic Therapy against *E Faecalis* using Endogenous Photosensitizer' in the 23rd Kerala Science Congress 2011.

Lekha G L and Narendra Babu K presented a paper entitled 'Sediment interstitial water phosphorus and the controlling factors that affects its migration to overlying water: A case study in two lake systems of different environments' in the 23rd Kerala Science Congress 2011.

Jean Jose J, Vishnu S Raj, Udayakumar P, Baiju R S and Narendra Babu K presented a paper entitled 'Extraction of marine microalgal chlorophyll pigment using Soxhlet apparatus for estimation-a convenient and effortless approach' in the 23rd Kerala Science Congress 2011.

Prijilal K G, Omana P K, Rajesh B R, Sajith U and Sindhu S presented a paper entitled 'Heavy metal Accumulation in the Estuarine Fishery Resource: A case study from Vembanad Estuarine System, Kerala, South West India' in the 23rd Kerala Science Congress 2011.

Resmi R, Baburaj B, Santhosh V, Sreebha S and Padmalal D presented a paper 'EIA of river sand mining using Rapid Impact Assessment Matrix (RIAM)- A case study' in National Seminar on Mining of river sand held at CWRDM Kozhikode, 18-19 February, 2011.

Anooja S, Baijulal B, Maya K, Sreeba S and Padmalal D presented a paper 'Impact of sand mining on river bed changes and bed material characteristics-a case analysis' in National Seminar on Mining of river sand held at CWRDM Kozhikode, 18-19 February, 2011.

Baijulal B, Jissy Jyothi S, Padmalal D, Maya K presented a paper 'Environmental effects of alluvial sand mining on the biological environment of Kerala rivers' in National Seminar on Mining of river sand held at CWRDM Kozhikode, 18-19 February, 2011.

Vishu Mohan S, Sreebha S, Padmalal D, Maya K and Lini Krishna presented a paper 'Sand mining in Pamba river' in National Seminar on Mining of river sand held at CWRDM Kozhikode, 18-19 February, 2011.

Narendra Babu K and Anoop Krishnan K presented the following papers 'Mapping and hydrochemical evaluation of coastal Spring of Southern Kerala, India, An alternate drinking water resource with high potential' and 'Impact of Urbanization on hydrochemical characteristics of three main cities, Thiruvananthapuram, Kochi & Kozhikode in Kerala, India' in International Conference Sustainable Water Resource Management and Treatment Technologies at NEERI, Nagpur, 19-21 January, 2011.

Sukumar B presented a paper 'Geomatic application for prioritization of watershed for watershed management in Kannur district, Kerala' in National seminar on Emerging Frontiers in Geomatic Applications ENFROG 2011 held at School of Earth and Atmospheric Sciences, Madurai Kamaraj University, Madurai, 21-22 March, 2011.

Ahalya Sukumar and Sukumar B presented a paper 'Growth of Chennai city and its envi-

ronmental impact: A study using Satellite remote sensing and GIS' in National seminar on Emerging Frontiers in Geomatic Applications ENFROG 2011 held at School of Earth and Atmospheric Sciences, Madurai Kamaraj University, Madurai, 21-22 March, 2011.

Deepthi B, Sukumar B and Ahalya Sukumar presented a paper 'Changing occupational structure of Kollam district, Kerala: A study using GIS' in National seminar on Emerging Frontiers in Geomatic Applications ENFROG 2011 held at School of Earth and Atmospheric Sciences, Madurai Kamaraj University, Madurai, 21-22 March, 2011.

Savitha Vijayan, Sukumar B and Ahalya Sukumar presented a paper 'Study of urbanization in Kannur district, Kerala through GIS' in National seminar on Emerging Frontiers in Geomatic Applications ENFROG 2011 held at School of Earth and Atmospheric Sciences, Madurai Kamaraj University, Madurai, 21-22 March, 2011.

Ahalya Sukumar and Sukumar B presented a paper 'Urbanisation between Kochi and Thrissur: An Integrated study using satellite Imagery and census data in GIS environment' in XXXI INCA International Conference at Chandigarh, October 2011.

Sandhya S, Deepthi P, Sukumar B and Ahalya Sukumar presented a paper 'Landuse land cover changes and its impact in Kollam district, Kerala: A study using GIS and Remote sensing' in XXXI INCA International Conference at Chandigarh, October 2011.

Deepthi P, Sukumar B, Ahalya Sukumar and Sandhya S presented a paper 'Mapping of soil moisture in Kollam District using NDVI and Tasseled cap analysis Authors' in XXXI INCA International Conference at Chandigarh, October 2011.

Sukumar B, Ahalya Sukumar, Sulfikkar M, Savitha Vijayan and Nadheer Bin Haneef O presented a paper 'Land and water conservation in Kannur district, Kerala: Watershed based GIS Analysis' in XXXI INCA International Conference at Chandigarh, October 2011.

Sulfikkar M, Nadheer Bin Haneef O, Ahalya Sukumar and Sukumar B presented a paper 'Panchayat wise analysis of food prone area and its impacts on agriculture in Kannur district,

Kerala' in XXXI INCA International Conference at Chandigarh, October 2011.

Nadheer Bin Haneef O, Sukumar B and Ahalya Sukumar presented a paper 'Urban growth and planning strategies in Kannur municipality, Kerala using Remote sensing and GIS' in XXXI INCA International Conference at Chandigarh, October, 2011.

Sudhanandh V S, Faisal A K, Vishnu S Raj, Baiju R S, Shibu R, Rajesh B R and Narendra Babu K presented a paper 'Physico-Chemical factors on the association of vibrio cholerae with phytoplankton, a case study using principal component analysis' in National seminar on Current Trend in Biotechnology and Bioinformatics held at NSS College Changanassery.

Omana P K, Prijlal K G, Rajesh B R, Sajith U and Sindhu S presented a paper 'Effects of Vilappillsala Waste treatment Plant lechate on surface and ground water quality status of Nearby Areas' in National seminar on Current Trend in Biotechnology and Bioinformatics held at NSS College Changanassery.

Ravindra Kumar G R presented a paper 'Growth and evolution of the Kerala Khondalite Belt, southern India: mineral and whole rock chemical evidence for intracrustal melting and magmatic petrogenesis' in American Geophysical Union conference.

Jayaprasad B K presented a paper 'Fragility Mapping for a strip of the western ghats using GIS- A case study in Amboori Gramapanchayat in Thiruvananthapuram district of Kerala State' in INCA International Seminar at Chandigarh, 16 October, 2011.

Padmalal D, Kumaran K P N, Nair K M, Ruta B Limaye and Vishnu Mohan S presented a poster on 'Late Quaternary Evolution of Vembanad Lagoon in the southwestern coast of India: an appraisal of sedimentary record of sea level and climate change' in the XVIII, INQUA Congress, held at Bern, Switzerland 22nd July, 2011.

Ruta B Limaye, Kumaran K P N and Padmalal D presented a poster on 'How did mangrove vegetation respond to Holocene sea level and climatic change along Konkan-Kerala coast of southwestern India?' in the XVIII, INQUA Congress, held at Bern, Switzerland, 22nd July, 2011.

Vandana M presented a paper 'A pedogeomorphic analysis of Kabani river basin in Wayanad district, Kerala' in International Geography Congress held at CWRDM, Kozhikode, 6-8 May, 2011.

Arun R presented a paper 'Feature space analysis for the classification of water bodies' in International Geography Congress held at CWRDM, Kozhikode, 6-8 May, 2011.

Arunima R, Noufal K N, Faisal A K, Sreejith M I, Arya S, Liji T M, Baiju R S and Anoop Krishnan K presented a poster on 'Natural springs-A promising solution for water scarcity in future?' National seminar of Frontiers in chemistry, Held at IIST, ISRO, Valiyamala, TVM, 7-8 December, 2011.

Anu baburaj, Subhash N, Nisha Unni, Anil M K and Rani Mary George presented a paper 'Laser-induced fluorescence imaging: A potential tool for early detection of coral bleaching' in 9th Indian Fisheries Forum, Chennai, 19-23 December, 2011.

Invited Talks

Dr. Srikumar Chattopadhyay delivered a lecture on Sustainable management of common property natural resources: macro perspective and micro act in the International Geography Congress held at CWRDM, Kozhikode, May 6, 2011.

Dr. Srikumar Chattopadhyay delivered a lecture on Disaster Management and Role of Local Self Government for the delegates from Bihar, Jharkhand & West Bengal.

Dr. K. Anoop Krishnan delivered a lecture on Water Quality status in Peninsular India-problems and possible remedies in the International Workshop on Asian water Environments (JSPS Asian Core Programme) on January 26, 2011 at Tokyo Institute of Technology, Tokyo, Japan.

Sri. G Sankar delivered a talk on Natural Disasters of Kerala in the Disaster, Risk and Vulnerability conference 2011 organized by the School of Environmental Sciences, MG University, Kottayam, March 12, 2011.

Sri. G Sankar delivered a talk on piping in the meeting organized by Madhavan Pillai foundation on March 19, 2011 at Trivandrum.

Sri. B K Jayaprasad delivered a lecture on Remote Sensing and GIS as a tool for Bio-resource Assessment on July 29, 2011 at Kerala Agriculture University.

Dr. P V S S K Vinayak delivered a lead talk on Global Warming on Climate Change in a national seminar at Acharya Nagarjuna University, Guntur.

Dr. A S K Nair delivered lectures on 'Water Resources and Irrigation Issued in Kerala' and 'Remote Sensing and GIS' during the STP Training Programme on GIS at the IMG, Thiruvananthapuram on 2nd September, 2011.

Dr. A S K Nair delivered a lecture on Participatory Rural Appraisal in the one day training programme under the Westernghat Development Programme on 29th September, 2011 at VJT Hall, Thiruvananthapuram.

Membership in Committees

Dr. N. P. Kurian

Member, Project Management Board, Coastal Engineering Division, National Institute of Ocean Technology, Ministry of Earth Sciences, Government of India.

Member, Board of Studies in Physical Oceanography under the Faculty of Marine Sciences, Cochin University of Science and Technology, Cochin.

Member, Kerala Dam Safety Authority by Water Resources (Inter State Water Cell) Department, Government of Kerala.

Member, Kerala Protection of River Banks of Regulation of Removal of Sand Rules 2002 – State High Level Committee for River Management Fund by Revenue (P) Department, Government of Kerala.

Member, Governing Body, LBS Centre for Science & Technology by Higher Education Department, Government of Kerala.

Member, Kerala Coastal Zone Management Authority by Ministry of Environment & Forests, Government of India.

Member, Working Group for Water Sector by Water Resources (IR) Department, Government of Kerala.

Member, Governing Body, Institute of Land and Disaster Management, Revenue Department, Government of Kerala.

Dr. Ajaykumar Varma

Chairman of the Committee constituted for assessing the damages to the properties of local people due to the blasting operations in a 7-km long tunnel of Sengulam Augmentation Scheme.

Expert Member in the Assessment Committee of C-DIT for the promotion of Scientist, Thiruvananthapuram.

Dr. C N Mohanan

Member, State Level EIA Authority (SEIAA)

Member, Technical Committee of Karumpukonam Community Ecosystem Management Committee constituted by Dept. of Environment & Climate Change.

Dr. N Subhash

Guest Editor of a Special Issue on Fluorescence in Natural Systems being brought out by the International Journal of Spectroscopy (Hindawi Publishing Corporation, USA)

Member of the Governing Council of STIC (Sophisticated Test & Instrumentation Centre), Cochin.

Dr. K. V. Thomas

Member, different KCZMA subcommittees to look into various CRZ issue of implementation, policies and violations and prepared reports.

New Arrivals in CESS Library

Yang, Xiaojin (Ed). Remote sensing and geospatial technologies for coastal ecosystem assessment and management. Springer, Heidelberg, 2009.

Kalacska, Margaret and Sanchez-Azofeifa, G Arturo (Ed). Hyperspectral remote sensing of tropical and sub tropical forests. CRC Press, Boca Raton, 2009.

Hall, G. Brent and Leahy, Michael G. (Eds.). Open source approaches in spatial data handling. Springer, Heidelberg, 2008.

Hawking, Stephen. A brief history of time. Bantam Dell Publishing Group, New York, 1989.

Pinker, Steven. The language instinct: the new science of language and mind. Penguin Books, London, 1994.

Koestler, Arthur and Butterfield, Herbert. Sleepwalkers. Penguin books, London, 1989. Ball, Philip. H2O: A biography of water. Phoenix, Britain, 1999.

Feynman, Richard. The pleasure of finding things out. Penguin Books, London, 1999.

Hawking, Stephen and Mlodinow, Leonard. The grand design. Bantam Dell Publishing Group, New York, 2010.

Goldys, Ewa M. Fluorescence applications in bio-technology and the life sciences. Wiley-Blackwell, New York, 2009.

Allan, Catherine and Stankey, George H. (Eds.). Adaptive environmental management. Springer, Heidelberg, 2009.

Sullivan, Patrick J., Agardy, Franklin J. and Clark, James J.J. The environmental science of drinking water. Elsevier, Amsterdam, 2005.

Boggs, Sam Jr. Principles of sedimentology and stratigraphy. 4th ed. Pearson Prentice Hall, New Jersey, 2010.

Grigg, Neil M. Water resources management: principles, regulations and cases. Mc-Graw Hill, New York, 2009.

Southward, Alan J., Young, Craig M. and Fuiman, Lee A. (Eds.). Advances in marine biology. Vol.50. Elsevier, Amsterdam, 2006.

Buchholz, Klaus and Collins, John. Concepts in biotechnology: history, science and business. Wiley-VCH, Weinheim, 2010.

Nierenberg, William A. (Ed.). Encyclopedia of environmental biology. Vol.1-3. Academic Press, Amsterdam, 1995.

Recruitments/Resignations

Smt. Indu Janardhanan, Technical Officer Grade 1 joined Estate Administration



Smt. Shimla D, Office Assistant Grade 1 joined Stores Section

Sri. Shinaj P.H Office Assistant Grade 1 joined Accounts Section



Smt. Anju. K. S Office Assistant Grade 1 joined Administration Section

Sri. Sudheer Kumar K, Driver Grade 1 joined Administration Section



Sri. Shensha C, Office Assisatant Grade 1 resigned on 31st January 2011 to take up employment in IIMK, Kozhikode

Sri. Subair V, Technical Officer Grade 1 resigned on 6th June 2011 to take up employment in IIMK, Kozhikode



Obituary

Dr. P. K. Iyengar



Dr. P. K. Iyengar, former Chairman of the Executive Committee of CESS and former Chairman of State Committee on Science Technology and Environment expired on 21st December 2011

Sri. K. R Unnikrishnan

Sri. K. R Unnikrishnan, Scientist-F, attached to the Camp Office CESS expired on 26th June 2011 after prolonged illness.



Prof. C. Karunakaran Endowment Lecture Series



Prof. Raghuram Murtugudde, Dept. of Atmospheric and Ocean Sciences of the Earth System Science Interdisciplinary Centre, University of Maryland, U.S.A delivering the Endowment Lecture

Prof. Raghuram Murtugudde, Dept. of Atmospheric and Ocean Sciences of the Earth System Science Inter-disciplinary Centre, University of Maryland, U.S.A, delivered the 10th lecture in the Prof. C.Karunakaran Endowment lecture series on 16th July 2011 at the CESS auditorium. The topic of the lecture was 'Earth, Life and Sustainability: A long-term perspective.

Prof. Murtugudde is internationally acclaimed for his contributions in earth system modelling. At present he is working on regional earth system prediction. The lecture

was attended by a large gathering of scientists and students from other institutions in and around Thiruvananthapuram. Dr. N. P. Kurian, Director, CESS welcomed the gathering. Shri. M. P. Muraleedharan, former Director, Geological Survey of India paid tributes to Prof. C. Karunakaran. Dr. K. Krishnamurthy, Director, Space Physics Laboratory, Vikram Sarabhai Space Centre introduced the speaker. Dr. Srikumar Chattopadhyay, Head, Resource Analysis Division proposed the vote of thanks.

Extension

Exhibition

CESS participated in the exhibition organized in connection with the 'Karshika Mela' (Agricultural fair) held at Thodupuzha Newmans College ground from 26th December 2011 to



A view of the exhibition stall of CESS at the agricultural fair held at Thodupuzha

1st January 2012. Every day nearly 20000 people visited the exhibition stall. Experts from

various fields delivered talks and conducted interaction sessions. CESS pavilion presented posters and models highlighting the research activities. Malayalam brochure titled '*Bhuchalanam: Ariyenda vasthuthakal*' and a hand book on CESS vision were distributed among the public.

CESS also organised and participated in the exhibition held during the 23rd Kerala Science Congress conducted in CESS from January 29-31, 2011.

Interaction programmes

Senior secondary students from the Bishop Hodges Higher Secondary School, Mavelikkara visited CESS on 27th July 2011. Scientists gave talks on Geographic Information System, Remote Sensing and Natural Hazards Management.



Scientists interacting with students of Bishop Hodges Higher Secondary School, Mavelikkara

Earth Day 2011



Scenes from Earth Day celebration

Earth Day 2011 was observed in CESS on 28th April 2011. Students from different schools in Thiruvananthapuram visited the laboratories of CESS and interacted with the scientists. An elocution competition for students was held on the topic 'Green Earth'. An invited talk on the same topic was also arranged for students. The talk was delivered by Shri. P. Narayana Kurup, a noted Environmentalist. Certificates, cash awards and mementoes were distributed to the winners by Director, CESS.

National Science Day 2011

'National Science Day' was observed on 28th February, 2011. Students from the Kendriya Vidyalayas visited CESS laboratories. A short talk on the focal theme, 'Chemistry in our Lives' was delivered by Sri.G.Balasubramonian, Scientist, CESS.

Honours/Awards



Mr. Sreejesh Kumar S, Project Fellow, Geosciences Division won the best poster award during 23rd Kerala Science Congress held at Trivandrum during January 29-31, 2011 for the paper titled 'Rainwater harvesting initiatives in Mullakkara Catchment, Chadayamangalam Block, Kollam district', based on a project on the Integrated Watershed Development Programme under

Hariyali. The paper was co-authored by Sri. John Mathai, Scientist-G, CESS.

Ph.D Awarded



Dr. V. R. Shamji has been awarded Ph.D Degree under the Faculty of Marine Sciences, Cochin University of Science and Technology, for his thesis 'Studies on beach morphological changes using numerical models'. Dr. N. P. Kurian, Director, Centre for Earth Science Studies was the supervising guide for the Ph.D dissertation work of Dr. V. R. Shamji.

Earth Science Forum

The Earth Science Forum initiated interactive sessions on frontier areas of Earth Sciences for the benefit of Post Graduate students in geology studying in different Universities in Kerala. The programme was inaugurated on 26th March 2011. Forty six students from the University of Kerala attended the inaugural session. Senior scientists of the Centre conducted interactive sessions for students on fifteen identified topics. The following lectures were delivered:

'Quality aspects and viable remedies for the restoration of Water Resources in Indian subcontinent' by Dr. K. Anoop Krishnan, Scientist, CESS; 'GIS Applications' by Mr. B. K. Jayaprasad, Scientist, CESS; 'Satellite communications for societal applications' by Dr. K. S. Das Gupta, Director, IIST, Trivandrum; 'Assessment of heavy metals in the environmental compartments of the central and northern coast of Kerala, by Sri. Udaya Kumar. P, Research Scholar, CESS and ' Numerical modelling of tsunami propagation in the South East Arabian Sea (SEAS) and inundation along the Kerala coast' by Mr. Praveen S. S, Senior Research Fellow, CESS.

Visit Abroad

Dr. Mahamaya Chattopadhyay

Dr. Mahamaya Chattopadhyay visited Bremen, Germany on invitation from the Centre for Tropical Marine Ecology (ZMT) for a period of three weeks starting from 15th May 2011 to 05th June 2011. The purpose of visit included developing and furthering discussions on the proposed collaborative project between CESS and ZMT,



Continued in page 10

Twentythird Kerala Science Congress



Hon'ble Chief Minister of Kerala Sri. V S Achuthanandan delivering the inaugural address of the 23rd Kerala Science Congress at the Centre for Earth Science Studies on 29th January 2011

Kerala Science Congress was organized during 29-31 January 2011. The three day event was inaugurated by the Hon'ble Chief Minister of Kerala Sri. V. S. Achuthanandan. Several national luminaries like Dr.K.Kasturirangan, Prof. Madhav Gadgil, Prof. Prabhath Patnaik, Prof. J. Sreenivasan were among the distinguished speakers. The Congress had around 800 registered delegates and a total of around 190 paper presentations including posters. 10 young scientist Awards and eleven best Poster Awards were presented.



Dr. C. T. S Nair, Executive Vice President, KSCSTE handing over a memento to the Hon'ble Chief Minister during the inaugural function..Dr. R.V. G. Menon, President of the Kerala Science Congress, Dr. K. Kasthurirangan, National Planning Commission, Dr. G. J. Samathanam, Advisor, Department of Science & Technology, Dr. K. K. Ramachandran, General Convener, 23rd Kerala Science Congress are also seen.



Prof. Madhav Gadgil, Garware College Pune, delivering the P.T. Baskara Panicker memorial lecture



Prof. Prabhat Patnaik, Vice Chairman, Kerala State Planning Board, delivering the Dr. P. K. Gopalakrishnan memorial lecture

Continued from page 9

on 'Interdependencies between Kerala rivers and backwaters: Consequences for water quality, ecology, economy and environmental governance'. Dr. Chattopadhyay delivered two lectures on 'Watershed characteristics and water quality: A case study of the Kall Ar basin, Kerala' and on 'Terrain evaluation of the Periyar Plateau, Kerala'.

Dr. Anoop Krishnan

Dr. Anoop Krishnan visited department of Civil Engineering, Tokyo Institute of Technology, Japan and delivered a talk on 'Water Quality Status in Peninsular India – Problems and Possible Remedies' as part of the workshop on 'Asian Water Environments' sponsored by the Japan Society for the Promotion of Science.



CESS and ONGC joint initiative on Fluid Inclusion Studies for Oil Exploration

Centre for Earth Science Studies joins hand with Oil and Natural Gas Commission on a study on 'Palaeo Fluids in the Petroliferous Basins of Western Offshore, India'. The study will attempt to locate the immense hydrocarbon reserves in the South Ratnagiri and Kerala-Konkan offshore basins. The Geo Fluids Research Laboratory (GFRL) of CESS will analyse the drill core samples that are made available by ONGC on a collaborative basis. The hydrocarbon potential of the Kerala- Konkan offshore basin extending from Goa in the North to Cape Comorin in the South is of the order of 660 million metric tonnes, according to ONGC estimates. The exploratory wells drilled in the Kerala- Konkan basin so far have not yielded oil. The proposed fluid inclusion study to be carried out at CESS involves detailed micro-level analysis of the palaeo fluids trapped inside minerals and cements present in the reservoir rocks of the Mumbai and Kerala- Konkan Basins. The study will provide valuable data about the temperature, salinity, pressure and composition of fluids that have migrated through the basin in the geological past, information that is of fundamental importance to the hydrocarbon exploration activities in the Kerala- Konkan Basin, which so far is designated as "dry" in terms of oil findings.

The technologies employed for the three- year

project and the data emerging out of the proposed work are expected to give India a cutting edge in its future oil exploration activities utilizing indigenous expertise. Dr. V. Nandakumar, Scientist, CESS is the Principal Project Co-ordinator and Principal Investigator of the project. Sri. H. Upadhyay, GM, Geology, Kesava Dev Malavia Institute of Petroleum Exploration (KDMIPE), Dehradun, is the Project Coordinator from the ONGC side. The study is fully supported by the Ministry of Earth Sciences, Government of India.

CESS Partners with Kerala State Disaster Management Authority to study hazard vulnerability and risk assessment

A research cell to study Hazard Vulnerability and Risk Assessment (HVRA) was set up by the Department of Revenue and Disaster Management, Kerala State Disaster Management Authority in collaboration with the Centre for Earth Science Studies and Institute of Land and Disaster Management. The first high level meeting of the HVRA Cell was held at Centre



Dr. Nivedita P Haran, Additional Chief Secretary, Department of Revenue and Disaster Management presiding over the first high level meeting of the Hazard Vulnerability and Risk Assessment Cell at Centre for Earth Science Studies, Thiruvananthapuram.

for Earth Science Studies on 12 May 2011. The meeting was presided over by Dr. Nivedita P Haran, Additional Chief Secretary, Department of Revenue and Disaster Management. The objectives of the meeting were to discuss *modus operandi* (i) to identify the available data, (ii) to initiate HVRA related data sharing between stakeholder departments, (iii) to collect and compile of data from stakeholder departments and institutions, (iv) to identify Nodal Officers from each department. The Addl. Chief Secretary in her presidential address declared

that the HVRA Cell has started functioning officially. She opined that this being the first of its kind in the country and the Government of India looks upon Kerala as the model for HVRA also, like many other 'Kerala Models'. Dr. N.P Kurian, Director CESS and Vice Chairman (Research) of the cell gave an invited address in the opening session. Shri. G. Sankar, Principal Investigator and Dr. Sekhar L. Kuriakose, Head (Scientist) HVRA Cell, provided a brief overview of the general approach towards conducting HVRA and the activities proposed in the first phase of the HVRA programme. The meeting had 4 rounds of expert's interactive sessions. Dr. C.T.S Nair, Executive Vice President, KSCSTE chaired the afternoon interactive sessions. Directors and Scientists of CESS, CWRDM, NATPAC, KSDI, KSREC and senior officials from Police, Fire & Rescue, Health, PWD, Agriculture, Forest and Irrigation participated in the meeting. The disaster related data available at different departments were identified and the delegates could arrive at a consensus for data sharing. Nodal officers for HVRA data sharing were identified from all organizations and departments who participated in the meeting. Smt. C. A. Latha, IAS, Hon. Secretary, SDMA delivered the welcome address and Sri. G. Sankar proposed vote of thanks.

Workshop on 'Interdependences between, rivers and backwaters: consequences for water quality ecology, economy and environmental governance

CESS has organised a workshop with Leibniz Centre for Tropical Marine Ecology (ZMT), Bremen during 21- 22, February 2011. Topic of the workshop was 'Interdependences between rivers and backwaters: consequences for water quality, ecology, economy and environmental governance: A case study of Kerala, India.' The workshop dwelt upon investigation of pollution effects on the ecology of aquatic organisms in the Vembanad lake ecosystem and its watershed through the contribution of multi-disciplinary approaches. Delegates from different departments of University of Kerala, Jawaharlal Nehru University, Directorate of Environment and Climate Change, Government of Kerala, etc. attended the workshop. Fruitful discussions and deliberations were held through two Technical Sessions.

Brain Storming Workshop on Earth System Sciences and Natural Resources Management



Dr. Shailesh Nayak, Chairman, RC, CESS & Secretary, Ministry of Earth Sciences, Government of India addressing the brain storming session

A Brain Storming Workshop was organized in CESS during July 21-22, 2011 with the objectives of having a critical appraisal of the various research activities that have been carried out at CESS with special reference to the current status at the national/international scenario and the developmental needs of the state, and working out a broad framework for the future agenda of research activities. The proceedings included an overview on the Centre's activities by the Director, presentations by the scientists of the Centre under a few broad themes, giving background and gist of the work carried out until now and the prospects of future research and the perceptions of the experts. The invited experts of different specializations who took part in the workshop were Dr. Shailesh Nayak, Chairman, RC, CESS & Secretary, Ministry of Earth

Sciences, Government of India, Prof. S. K. Tandon, Professor, Dept. of Geology and PVC (Retd), Delhi University, Dr. S. Sinha Roy, DDG, GSI (Retd.), Prof. V. Sundar, Dept. of Ocean Engineering, IIT Madras, Dr. P. Vethamony, Scientist-G, NIO, Dr. P.V. Joseph, Visiting Professor, Dept. of Atmospheric Sciences, Cochin University of Science & Technology, Dr. B. Nagender Nath, Scientist-G, NIO, Dr. H.S. Sharma, Dept. of Geography, University of Rajasthan, Dr. P.C.S. Devara, Scientist-G, IITM, Pune, Prof. P. Ravi Gupta, Dept. of Earth Sciences, IIT, Roorkee, Prof. Baleshwar Thakur, Professor (Retd), School of Geography, Delhi University, Dr. B.K. Saha, Member, RC, CESS & DDG, GSI (Retd.), Dr. K. Krishnamoorthy, Member, RC, CESS & Project Director, ARFI & Head, AACCR, Space Physics Laboratory, VSSC and Prof. V.N.

Sivasankara Pillai, Member, RC, CESS & Former Director, School of Environmental Sciences, CUSAT

The presentations, expert opinions and the perceptions on the future research activities covered the following themes viz. solid- earth geoscience studies, atmospheric electricity and minor constituents, coastal processes and coastal zone management, sedimentological and mineralogical aspects of coastal zone, Quaternary geology of Kerala, environmental quality and pollution, environmental studies and impact assessments, natural resources management, remote sensing of the environment and geomatics for planning and development. The objectives of the workshop were fully realised and the proceedings brought out for future reference.



Pictures taken on the occasion of the Onam celebrations organized by the CESS Recreation Club on September 2, 2011

Green Technology Centres in selected Grama Panchayats of Kerala

The Government proposed to launch a project for establishing Green Technology Centres (GTC) in selected Grama Panchayats and it was included as a priority programme. Accordingly, the Kerala State Council for Science, Technology & Environment (KSCSTE) entrusted the task of implementation to the Centre for Earth Science Studies (CESS). The project



Dr. M. K. Muneer, the Hon'ble Minister for Panchayats and Social Welfare formally inaugurating the launch of the project on Green Technology Centres at Grama Panchayats at CESS

envisages establishing one GTC in each local body to facilitate the installation, service and practice of the green technology, develop and popularize green technology products and processes, popularize and establish the practice of 'Reuse and Recycling' of materials, propagate high efficiency (smokeless or otherwise) cooking stoves, hot boxes, solar water heaters etc, reduce waste generation and energy consumption, safeguard local environment from increasing pollution, toxicity and natural resource crunch, optimize the use of building materials by promoting green building technology, promote organic farming, homestead farming, energy plantation and micro mechanization in agriculture and organize qualified and trained Green Technicians at local bodies in the form of Green Technology Groups.

The project, to be implemented initially in selected Grama Panchayats, will be given hand-holding support during the initial period through organizations with experience in green initiatives and participatory actions at the local level. The project was formally launched by Dr. M. K. Muneer, the Hon'ble Minister for Panchayats and Social Welfare on 25th August 2011 at CESS. A plan meeting to discuss and decide the way-forward of the project was also organized on the same day. Scientists from various R&D Centres in the State, experienced non-governmental organizations namely, Peerumedu Development Society, Kuttanad Vikasana Samithi, Mythri, Uravu, Integrated Rural Technology Centre and officials of development departments participated.

CESS to study soil piping

The National Disaster Management Authority (NDMA), Govt. of India, HVRA Cell of the Department of Revenue, Govt. of Kerala and CESS have signed a memorandum of understanding (MoU) to take up detailed studies on "soil piping" or "tunnel erosion" – the formation of subsurface tunnels due to subsurface soil erosion. Through this project it is proposed to document areas affected by piping in Kerala and evolve a mapping technique to determine the extent of the underground network of pipes



using geophysical and geologic methods. The investigating team shall carry out physical, chemical and geotechnical analysis of the soil in the affected areas to understand the causes of piping. The subsurface mapping would require equipments such as, imaging resistivity meters

and vibration sensing equipments. Tracer studies will also be conducted to determine the pipe layout and GPR studies shall be initiated wherever required. Mathematical modeling will be done to identify the most vulnerable areas. The investigating team will also come up with site specific mitigation measures to minimize/ arrest the process.

Retirements

Sri. B Sukumar



Sri. B. Sukumar, Scientist-F, Resources Analysis Division retired on 30th September 2011.

Dr. S. Muralidas



Dr. S. Muralidas, Scientist-F, Atmospheric Sciences Division, retired on 28th February 2011.

Dr. K. Narendra Babu



Dr. K. Narendra Babu, Scientist-F and Head, Chemical Sciences Division, retired on 31st October 2011

Sri. G. Balasubramanian



Sri. G. Balasubramanian, Scientist-F and Head, Training and Extension Division, retired on 30th April 2011

Sri. R. Sivarajan Pillai



Sri. R. Sivarajan Pillai, Technical Assistant Grade-5 (Draftsman), Training and Extension Division, retired on 31st January 2011

Sri. C. Surendran

Sri. C. Surendran, Skilled Assistant, Estate Administration, retired on 30th April 2011

