

GEM- 2017

PROGRAM

06th to 08th FEBRUARY, 2017



**Department of Geology and
Environmental Science**

Christ College (Autonomous) Irinjalakuda

MEETING PROGRAM- GEM 2017

06-02-2017 ; Monday

Inauguration

9:30- 10:15

Palaeoclimate: proxies of the past

Sl No.	Name	Address	Title	E-mail	Time
1	Dr. Rajiv Nigam	National Institute of Oceanography, Dona Paula Goa-403004	Why and How to reconstruct the past Climate?	nigam@nio.org	10:15- 11:00
TEA BREAK					
2	Dr.Thamban Meloth	National Centre for Antarctic and Ocean Research (Ministry of Earth Sciences), Headland Sada, Vasco da Gama, Goa - 403 804	Effect of Climate Change on Antarctic ice sheets and Himalayan Glaciers	meloth@ncaor.gov.in ; tmeloth@gmail.com	11:20- 11:55
3	Dr. Dr.S.M.Hussain	Department of Geology, University of Madras, Guindy Campus, Chennai- 600 025, India	Distribution and statistical aspects of Ostracoda: Implications on (paleo) environment and hydrocarbon potential of the sediments	smhussain7@hotmail.com	11:55- 12:30
LUNCH BREAK					
4	Bhavatharini Shanmuganathan	PG and Research Department of Biotechnology, National College (Autonomous), Tiruchirappalli – 620 001, Tamil Nadu, India	Bacteria as proxies for paleo sea-level and paleoclimatic reconstruction: A Geobiotechnological perspective	senthil@nct.ac.in	13:30- 13:50
5	Christinal Jayaseelan	PG & Research Department of Geology, National College, Tiruchirappalli, Tamilnadu- 620 001	Inner shelf environment off Kayalpattinam, southeast coast of India and its impact on the distribution of Benthic Foraminifera.	ms.christinalj@gmail.com	13:50- 14:10

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6	Dinagara Pandi P	School of Mechanical and Building Sciences, VIT University, Chennai, Tamilnadu, India.	A Factor Analysis of Morphometric Parameters	mohan.kuppusamy@vit.ac.in	14:10- 14:30
7	NIRMAL BIJU	School of Advanced Sciences, Vellore Institute of Technology, Chennai, Tamil Nadu, India.	Late Neogene planktonic foraminiferal distribution and their relationships to paleoceanographic changes	mohan.kuppusamy@vit.ac.in	14:30- 14:50
8	Dr. Elango L.	Department of Geology, Anna University, Chennai, India	Seawater intrusion: Assessment and Mitigation Measures	elango@annauniv.edu	14:50- 15:25
TEA BREAK					
9	Dr. Morthekai, P.	Birbal Sahni Institute of Palaeosciences, 53 University Road, Lucknow, India.	Philosophies for palaeosciences: a mini-review by a quasi-expert	morthekai@gmail.com	15:45- 16:20
10	Dr. Sijinkumar A V	Department of Geology, Central University of Kerala, Kasaragod, Kerala, India	Indian monsoon rainfall variability: evidence from the late Quaternary sediments of the Andaman Sea.	sijingeo@gmail.com	16:20- 16:55
11	Dr. Lekshmy PR	Department of Atmospheric Sciences, Cochin university of Science and technology, Cochin, India	Recent advances in stable isotope hydrology studies over India: Implication to paleo monsoon reconstruction	lekshmy@cusat.ac.in	16:55- 17:30

MEETING PROGRAM- GEM 2017

07-02-2017 ; Tuesday

Petrology: analytical and field geology

12	Dr. Pradeepkumar A.V.	Department of Geology, University of Kerala, Kariavattom, Trivandrum 695 581, India	Instrumentation for petrology research in Kerala	geo.pradeep@keralau niversity.ac.in	09:00-09:35
13	Dr. Prabhakar Naraga	Department of Earth Sciences, Indian Institute of Technology Bombay, Mumbai, Maharashtra, India	Significance of petrologic P–T path and EMP monazite ages from the metapelites, Nellore schist belt, Southeastern India	prabhakarnaraga@gm ail.com	09:35-10:10
14	Dr. Saju Menacherry	Reservoir Quality Specialist, Chevron Australia, Perth, Australia	Aspects of Sedimentary Petrology that Impact on Petroleum Exploration	smenacherry@gmail.c om	10:10-10:45
15	Dr. Baiju K.R.	Department of Marine Geology and Geophysics, Cochin University of Science and Technology, Kochi, India	Implications of saline brine inclusions in charnockites of the Madurai Granulite Block, southern India	baijukr@gmail.com	10:45-11:05
TEA BREAK					
16	Tanzil Deshmukh	Department of Earth Sciences, Indian Institute of Technology Bombay, Mumbai, Maharashtra, India	P–T–t evolution of the Mahakoshal supracrustal belt, Central India: Evidences from a corridor study	tanzil.deshmukh@gm ail.com	11:20-11:40
17	Thamam Mubarish	Centre for Earth Sciences, Indian Institute of Science, Bangalore 560012, India	Significance of corona textures in ultrahigh temperature assemblages: A petrological approach towards continental correlation	thamam123@gmail.co m	11:40-12:00
18	Abiya Lukose	<i>Department of Geology, University of Madras, Guindy Campus, Chennai, Tamilnadu, India</i>	Texture and Geochemical analysis in the core sediments of Kadalundi rivermouth, Kerala- its environmental implications	<i>msureshgandhi@gmai l.com</i>	12:00-12:20

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19	Devi K.	MS-PhD Scholar, Petroleum Engineering Programme, Department of Ocean Engineering, Indian Institute of Technology, Madras, Chennai, India	Case studies of Ground Penetrating Radar (GPR) applications in Engineering and Geosciences	rajeshnair@iitm.ac.in	12:20-12:40
LUNCH BREAK					
Remote Sensing and GIS in Earth and Planetary Science					
20	Dr. Rajesh V.J.	Department of Earth and Space Sciences, Indian Institute of Space Science and Technology, Valiamala P.O., Thiruvananthapuram 695 547, Kerala	Spinel-bearing Anorthosites in southern India as Probable Terrestrial Analogues to Lunar Highland Crust	rajeshvj@iist.ac.in; rajeshvj2000@gmail.com	13:20-13:55
21	Dr. Kusuma K.N.	Department of Earth Sciences, University of Pondicherry, Pondicherry, India	Exploring Martian Geology using Remote Sensing and GIS	Kusuma.kn@gmail.com	13:55-14:30
22	Sriganesh Jeyagopal	Centre for Remote Sensing and Geoinformatics, Sathyabama University, Chennai, Tamil Nadu, India	Assessment of Tsunami Hazard for Cuddalore Coast, South East India	sriganeshgeo@gmail.com	14:30-14:50
23	Naveen Eldho Paul	P. G. Diploma, Water Resource Department, Indian Institute of Remote Sensing, Dehradun, India	Assessment of the water balance and morphometric analysis using remote sensing and GIS of two sub-basins		14:50-15:10
TEA BREAK					
Geochronology and Isotope geochemistry					
24	Dr. Manfred Frechen	Leibniz Institute for Applied Geophysics (LIAG), Stilleweg 2, 30655 Hannover, Germany	OSL Dating of Coastal Sediments	Manfred.Frechen@liag-hannover.de	15:30-16:05

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25	Dr. Rabiul Haque Biswas	Institute of Earth Surface Dynamics, University of Lausanne, Lausanne, Switzerland	Thermal History of Rocks	biswasrabiul@gmail.com	16:05-16:25
26	Thena T.	School of Advanced Sciences, Vellore Institute of Technology, Chennai, Tamil Nadu, India.	Response of the benthic foraminiferal community records and geochemical approaches at Cascadia Margin	mohan.kuppusamy@vit.ac.in	16:25-16:45
27	Rithin Varghese C.	Indian Cardamom Research Institute, Spices Board India, Myladumpara, Kerala, India	Paleo-environmental evidences of the Spice trade and Plant utilization from the Peat formation of Pattanam Archaeological site	rithinvarghez@gmail.com	16:45-17:05
08-02-2017 ; Wednesday					
Hydrogeology and water management					
28	Dr. Girish Gopinath	Senior Scientist, Geomatics Division, Centre for Water Resources Development and Management (CWRDM)	Application of Geomatics in Water Resources Management	gg@cwrmdm.org	09:00-09:35
29	Chinchumol S	Groundwater Division, CWRDM, Kozhikode, India	Estimation of Rainfall recharge using Infiltration Technique in Keecheri-Puzhakkal River basins, central Kerala	cppriju@gmail.com	09:35-09:55
30	Dr. Shaji E.	Dept. of Geology, University of Kerala, Kariavattom campus, Trivandrum-695581.India	A low cost domestic defluoridation filter – a Case study from Palghat, Kerala, India	shajigeology@gmail.com	09:55-10:15
31	Raicy Mani Christy	Department of Geology, Anna University, Chennai, Tamil Nadu, India	Assessment of impact of managed aquifer recharge structures; A comparative study	elango34@hotmail.com	10:15-10:35
32	Ramya Priya Ramesh	Department of Geology, Anna University, Chennai, Tamil Nadu, India	Assessment of river water and groundwater quality in the coastal part of Cauvery river, India	elango34@hotmail.com	10:35-10:55
TEA BREAK					

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Environmental Geology					
33	Sinta K B	Department of Geology and Environmental Science, Christ College, Irinjalakuda, Kerala, India	Hydro chemical characteristics of Muriyad wetlands, Kerala-An Appraisal	sintakalesh@gmail.com	11:15-11:35
34	Rethikala K R	Department of Geology and water Management, B. K. College for women, Amalagiri, Kottayam- 686 561	Substrate characters and its influence on the distribution of benthic foraminifera from the inner shelf sediments of southern part of Gulf of Mannar, southeast coast of India.	sekhar.ashok@gmail.com	11:35-11:55
35	Satish Balakrishnan	Coal India Limited, CMPDI, Exploration Department, Bilaspur, Chattisgarh- 495 006	Temporal variation of inner shelf environments and its effect on the distribution of Ostracoda from the southern part of Gulf of Mannar, Southeast coast of India.	satishmyluv@gmail.com	11:55-12:15
36	Dr. Subin K. Jose	Geology and environmental science, Christ College, Irinjalakuda	Human Elephant Conflict Detection and Mapping Using Geoinformatics	josesubin@gmail.com	12:15-12:35
37	Gopakumar P.G	Department of Geology and Environmental Science, Christ College, Irinjalakuda, Kerala, India	Preliminary investigation on the formation of Muriyad wetlands, Kerala South India	gopakumarsulu@gmail.com	12:35- 12:55
LUNCH BREAK					
Veledictory session					

GEM- 2017

ABSTRACTS- ORAL & POSTER
PRESENTATIONS

06th to 08th FEBRUARY, 2017



**Department of Geology and
Environmental Science**

Christ College (Autonomous) Irinjalakuda

Seasonal Variation in Beach Profiling along Coastal Tracts of Andathode to Ponnani Region, Kerala

P.K. Abdul Nafih¹

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Beaches are one of the most dynamic environments that tend to change their size and shape in response to the variation in the wave climate. This contribution attempts to estimate erosion and accretion along on such a dynamic coastal stretch extending along Andathode - Ponnani beach during pre-monsoon, monsoon and post-monsoon seasons of April 2014–January 2015. A systematic fieldwork has been carried out at a total of 10 stations, fixed at an interval of 1 km for profiling. Beach profile variations and hydrodynamic parameters were monitored along Andathode–Ponnani beach from ten selected stations. It is observed that the morphological change of the beach is cyclic. i.e., erosion during monsoon, deposition during pre-monsoon and gradual erosion and deposition during post monsoon seasons along the study area. It is observed that the beaches in the middle part of the study area are more affected by wave action. These areas are protected by huge sea walls but due to severe erosion the older sea walls are collapsed and even causing collapse of the buildings that were present in the pre-monsoon period due to extreme wave action in the monsoon season. Northern and southern part of the study area are subjected to season wise cyclical changes, i.e., erosion during monsoon, deposition during pre-monsoon and gradual erosion and deposition during post monsoon. The wave breaker height observed in this region suggests prevalence of low- to moderate-energy conditions along the coast. The breakers were plunging during pre-monsoon, while plunging and spilling breakers are observed during monsoon. Long period waves dominate during pre-monsoon period, while the short period during the monsoon and are more erosive than the former.

Texture and Geochemical analysis in the core sediments of Kadalundi rivermouth, Kerala- its environmental implications

Dr.M.Suresh Gandhi¹, Abiya Lukose²,

Department of Geology, University of Madras, Guindy Campus, Chennai, Tamilnadu, India

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The Kadalundi estuary is situated in Kerala. The study area is dominated with mangroves, conserved as a bird sanctuary. Near the Kadalundi, the Beypore estuary has been studied in detail. Hence, for the first time an attempt has been made in this area to delineate the paleoenvironmental conditions in this region. One core sample has been collected up to 185 cm and sub sampled in 5 cm intervals. Based on sand-silt clay ratio, the study area is dominated with sand. The calcium carbonate and organic matter content is very low in percentage. The higher values of organic matter are observed in the top and bottom core, where as in the middle core it is slightly decreased. The sediment texture shows poorly sorted nature with a frequency pattern of Polymodal distribution. Further, positively skewed nature implies the prevalence of low energy environments in different wave directions, entailing a mixed distribution of fine sediments. i.e. one derived from riverine/aeolian environment and the other primarily derived from marine environment. This is also attributable to the widely varying nature of sediments and change in gradients of the coastline.

The heavy mineral assemblage of the study area is governed by the distribution of low and high ranked metamorphic rocks and some basic igneous rocks. The presence of a little amount of zircon in the top core implies the influence of marine inputs by reworked sediments. XRF data resembles a sudden increase in the concentration of Fe > Mn > Cr > Cu > Ni > Zn at a depth of 130 cm depicts that, these trace elements mainly get associated with silt and clayey materials in the sediments. These elements show a positive relation with silt, clay and organic matter in the sediments. Lesser concentration of these elements indicates that the area is not much polluted and mangroves play a vital role in absorption of toxic elements. XRD analysis shows that, Illite was present in all samples designate the emergence of estuary into Arabian Sea and the reworking of waves. Illite may be formed by the alteration of mica minerals. From the overall study it is concluded that the river discharge from Kadalundi, deposits an additional sub-population of sand with a mean size of sediment from medium to fine grained in nature where low-energy conditions prevail and accretionary processes are taking place with mixed environments.

Deciphering Groundwater Potential in Hard Rock Terrain of Karnataka using Geo-electrical and GIS Techniques

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The present study aims to delineate subsurface and to determine groundwater potential zones of Hirehalla Sub-basin (HSB) of Hoovina Hadagali and Harapanahalli Taluks of Karnataka. Geologically, it is underlain by hard Peninsular Gneissic Complex (PGC). Geomorphologically, drainage pattern is dendritic to sub-dendritic. Twenty (20) Vertical Electrical Soundings (VES) were carried out covering entire study area. Different thematic maps were generated in GIS environment. Obtained VES data were analyzed and interpreted quantitatively. Quantitative interpretation of VES data shows three to four layer profiles. First layer, resistivity shows variation from 3 to 86 Ωm and thickness varies from 0.5 to 3.8 m. Second layer, resistivity shows variation from 1 to 315 Ωm and thickness varies from 0.72 to 34.66 m. Further, third layer resistivity shows variation from 3 to 28393 Ωm and thickness varies from 1.9 to 40.8 m. The study area is dominant of A & HA type of curves. From the interpretation and assessment of VES data of HSB it can be inferred that Central and South-western parts show anomalies of high resistivity for all the depths indicating hard formations. Rest of the study area showing low resistivity anomalies indicates weathered/fractured sub-surface formation which favors groundwater potential. Further, application of GIS has proved to be very efficient tool in interpretation of geophysical studies.

- [1] Flathe, H. 1955. Possibilities and limitations in applying geoelectrical methods to hydrogeological problems in coastal areas of Northwest Germany. *Geophysical Prospecting*, V, 3, No.2, pp. 95-110.
- [2] Fitterman, D.V and Stewart, M.T. 1986. Transient electromagnetic sounding for groundwater. *Geophysics* 51:995–1005
- [3] Oreelana, E and Mooney, H.M. 1966. Master curves and tables for vertical electrical soundings overlayered structures. Interciencia, Madrid.
- [4] Reynolds, J. M. 1997. An introduction to Applied and Environmental Geophysics. John Wiley & sons Ltd. Chichester England.
- [5] Telford, W.M., Geldart, L.P., Sheriff, RE. and Keys, D.A. 1990. *Applied Geophysics*. Cambridge University press, 770 p.

Deformation pattern of high grade metamorphic rocks along the southwestern margin of Madurai granulite block, southern India

Amaldev T¹, Baiju K.R¹

¹ *Department of Marine Geology and Geophysics, Cochin University of Science and Technology, Lakeside Campus, Fine arts avenue, Kochi – 16, Kerala, India*

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The Southern Granulite Terrain (SGT), one among the classic granulite terrains in the world is a collage of continental blocks ranging in age from Mesoarchean through Neoarchean and Paleoproterozoic to late Neoproterozoic–Cambrian. In the present study we discuss the detailed geology, structure and metamorphic conditions along the southwestern margin of the Madurai granulite block. Major rock type occurred in the area is charnockite with its minor compositional and deformed variants. The other important rock types noticed in and around Kottayam area are pyroxene granulites, granitic gneisses, hornblende biotite gneisses and younger intrusives found as dolerites and pegmatites. Minor occurrence of cordierite bearing metapelites were also found as thin bands. The fabric of the rocks reflects deformation and metamorphic recrystallisation. The petrographic evidence which support the metamorphic origin of these rocks include porphyroblasts of garnet, polysynthetic twinning of plagioclase, and preferred orientation of biotite grains. The primary planar structures are not well preserved in the region due to intense metamorphism and subsequent deformation. Presence of foliated charnockite along with massive charnockite indicate that the region has undergone retrograde metamorphism. Biotite flakes at orthopyroxene rims together with magnetite and quartz indicate retrograde reaction texture. The presence of biotite inclusion within garnet indicates retrograde metamorphism. Due to high grade metamorphism and weathering the primary planar structures (So) are obliterated in the area. Secondary planar structures (S1) present in the area include penetrative foliation defined by preferred dimensional orientation of quartz- feldspathic mineral and elongated hornblende and biotite. The foliation has a general WNW- ESE trend. Minor folds are observed at places. Systematic analysis of structures reveals that the area has been affected by polyphase deformation. Three generations of folds are developed due to deformation. Of these F1 folds are isoclinal and are present as rootless folds. F2 folds are tight to close folds on foliation. The third generation folds (F3) are represented by broad open folds. The geometry and orientation of F1 and F2 folds are affected by the third generation folds, resulting in superposed folding in the area.

The Lost River of Harappan Civilization: Recent Geochemical Perspectives

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Not every day one comes across a problem where history, mythology and science meet at a crossroad. One such enigmatic example is the putative existence of a glacier-fed river during the Bronze Age Harappan Civilization and its association with the mythological river Saraswati of Rig-Veda. The river Saraswati has often been correlated to the present day ephemeral Ghaggar-Hakra river of north-west India due to its matching geographical position with the former. This hypothesis further strengthened with the discovery of numerous Bronze Age Harappan settlements along the dry channels of Ghaggar-Hakra. Although satellite imagery based studies showed the existence of buried paleo-channels along the Ghaggar-Hakra river, their connection to glacial source as well as their existence during Holocene remained a conjecture until recently. Combined geochronological and geochemical studies of the Ghaggar-Hakra alluvium has finally started to reveal the evolution of the river system over the geologic past. In this review, applications of different geochemical and geochronological techniques, which help us deciphering sedimentary archives, are discussed with the examples from the Ghaggar alluvium. The initial studies based on bulk sediment Sr-Nd isotopic fingerprinting of alluvium deposits indicated a probable Sub-Himalayan origin of the Ghaggar river without any glacial connection in the geologic past [1]. However, the U-Pb dating of detrital zircons revealed possible connections of Sutlej, Beas and Yamuna to the paleo-Ghaggar channel during the Pleistocene [2]. In a recent study it has been shown, how climate controlled the sediment erosion and supply to the Ghaggar alluvium during the last 150 ka [3]. Their study based on Sr-Nd isotopes also indicates that older sediments in Ghaggar alluvium were probably sourced from glaciers. However, none of these studies could unequivocally prove the existence of a mega fluvial system during the Harappan time. On the other hand, several geochronological works have given hints of strong fluvial activities during mid-Holocene [4]. This review will discuss our present understanding of the long debated topic under the light of geochemistry and try to inspect the future possibilities to fill the gaps in the story.

[1] Tripathi, J., Bock, B., Rajamani, V. 2004. Is River Ghaggar, Saraswati? Geochemical constraints. *Current Science*. 87 (8), page 1141-1145.

[2] Clift, P.D., Carter, A., Giosan, L., Durcan, J., Duller, G. A. T., Macklin, M.G., Alizai, A., Tabrez, A. R., Danish, M., VanLaningham, S., Fuller, D.Q. 2012. U-Pb zircon dating evidence for a Pleistocene Saraswati River and capture of the Yamuna River. *Geology*. 40, pages 211–214.

[3] Singh, A., Paul, D., Sinha, R., Thomsen, K.J., Gupta, S. 2016. Geochemistry of buried river sediments from Ghaggar Plains, NW India: Multi-proxy records of variations in provenance, paleoclimate, and paleovegetation patterns in the Late Quaternary. *Paleogeography, Paleoclimatology, Paleoecology*. 449, pages 85–100.

[4] Saini, H.S., Tandon, S.K., Mujtaba, S.A.I., Pant, N.C., Khorana, R.K. 2009. Reconstruction of buried channel-floodplain system of the northwestern Haryana Plains and their relation to the 'Vedic' Saraswati. *Current Science*. 97. Pages 1634–1643.

Isotopic variation and role of climate in water budget of the river Ganga, India

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Global climatic change due to rise in greenhouse gases by human activities is likely to increase the temperature and subsequently alter the large scale rainfall regime through enhanced glacier melt. The severity of the global climate change does not only depend on the magnitude, but also on its potential of irreversibility for several years. Consequently, the hydrology of several rivers, which shape livelihood of large population, would be impacted by the irreversible global climatic change. However, the interplay of climate change and hydrology of Indian rivers is yet to be critically evaluated. In attempt to understand the influence of climate and hydrology in the Ganga basin, $\delta^{18}\text{O}$ and δD values of river water, ground water and rain water in selected places have been used. Water samples from the river Ganga were collected from its source (Gangotri glacier) to sink in the Bay of Bengal during post-monsoon period. Three years monthly sample of river water and daily sampling of rain water were collected from middle (Kanpur) and lower (Kolkata) stretch of the river. The $\delta^{18}\text{O}$ values of river water from source to sink shows an increase in values with variations from -14.9‰ to -6.2‰ . The $\delta^{18}\text{O}$ values of the ground water vary from -9.0‰ to -5.1‰ throughout the stretch of river. The cross plots of $\delta^{18}\text{O}$ and δD values of rain water, ground water and river water show the effect of climate. The $\delta^{18}\text{O}$ and EC value of the melt water, ground water and rain water have been used to estimate the relative fraction of each of the component in different stretch of the river. The relative contributions of glacier melt decrease downstream of the river with maximum 30% contribution in the upper stretch of the river. The groundwater contribution is maximum in the middle stretch of the river. The surface runoff contribution increases downstream of the river.

Groundwater quality studies of Poonthura-Veli Coastal stretch, Thiruvananthapuram, Kerala

Arathi,G.P¹, Mohanty,A.K²

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The present study focuses on the assessment of major ion chemistry of groundwater samples in the Poonthura- Veli coastal stretch, Thiruvananthapuram District, Southern part of Kerala state. The objective of the work is to study the hydrogeology, water quality parameters, hydrogeochemistry and a comparison has been made with BIS and WHO drinking water quality standards. The study area is a part of the drainage basin of Vamanapuram River and Parvathy Puthanaar Canal linked with Karamana River. The broad geology of the region constitute crystalline basement of Archean rocks overlain by sedimentary formations of Eocene to Recent age. The area experiences humid tropical savanna climate. In the present study, 15 groundwater samples were collected from dug wells and tube wells. These observation wells and their corresponding coordinates were plotted with the help of SURFER software. Physico-chemical parameters such as pH (5.93 – 7.86), Electrical Conductivity (156 – 2230 μ S/cm), Total Dissolved solids (72 – 1160 mg/l), Total Hardness (70- 382 mg/l) along with cations such as Na (7- 157 mg/l), K (2- 37 mg/l), Ca (20.04-100 mg/l), Mg (0-32 mg/l) and anions such as SO_4 (0-94 mg/l), NO_3 (30.2-198.7 mg/l), Cl (14.2-300 mg/l), F (0.211-0.759 ppm) HCO_3 (24-270 mg/l) were determined by the standard APHA (1995) procedures. The results were evaluated in accordance with drinking water quality guidelines recommended by the Bureau of Indian Standards Specifications (BIS 2012) and World Health Organization (WHO 2008). Groundwater chemistry in the study area reveals that, pH of samples are near neutral. The TDS concentrations of the groundwater samples found within the permissible limits of BIS drinking water standards. Based on TDS values, more than 70% of the groundwater samples are desirable for drinking. Based on the total hardness value 50% of groundwater samples are moderately hard, and rest of the samples are hard. Cation and anion concentrations in the groundwater samples indicate that, majority of the water samples are suitable for drinking. But the nitrate concentration indicates that, only 20% of the samples are suitable for drinking purpose, while most of the samples show higher levels of concentration than recommended value. Assessment of water samples from %Na and SAR indicates that chemically groundwater samples are suitable for irrigation. Chloroalkaline index indicates the direct base exchange reaction between Na, K and Ca, Mg in the aquifer material, but majority are in disequilibrium condition. In the rock-water interaction, Gibbs plot indicates the chemical weathering of rock forming minerals in the aquifer is the predominant hydrochemical mechanism controlling the chemical composition of groundwater in the aquifer. Wilcox diagram shows that equal number of samples fall in low sodium and medium salinity hazard and low sodium high salinity hazard. The range of concentration of sodium in the study area shows that they are suitable for drinking purpose.

A New Green Protocol For The Synthesis Of N-substituted β -amino carbonyl compounds

Arun S^{1*}

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The traditional chemical industry was a hazardous and polluting one. It generated stoichiometric amounts of waste, causing much pollution of both air and water. Today, the escalating costs of petrochemicals and increasing energy and raw material consumption forcing a change. As a consequence the industry demands from chemists the development of new reaction methodologies to obtain novel compounds in a fast, clean and efficient way. In this scenario, multicomponent reactions (MCRs) offer an alternative to the traditional synthesis mainly because it is based on available starting materials, operationally simple, easily automatable, resource effective, atom economical and ecologically benign. Our continuing interest in developing the methodology as a novel route to access highly functionalized structural scaffolds (β -amino carbonyl compounds) in a cost effective, environmentally friendly and a more importantly, a process requires less operational skills and conditions.

A study on hydrocarbon generation in space and time with particular reference to relative plate motions and petroliferous basin location and evolution

Jagannadha Rao M¹, Asif Iqbal Kakkassery¹, Jalla Ramesh¹, Dona Augustine¹

¹*Department of Geology, Andhra University, Visakapatnam,
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The Global Hydrocarbon generation has been a subject of scientific discussion. The spatial and temporal variability in hydrocarbon genesis, occurrence, abundance etc. are dependent upon various complex geological factors which are difficult to fully comprehend. It is very clearly established that there is considerable relationship between the plate positions and hydrocarbon generation in stratigraphic ages. The petroliferous basins in relation to their location and will give information on the favorable geological factors that helped the hydrocarbon generation and accumulation. In this investigation an attempt has been made to understand the spatial distribution of major oil fields with reference to their stratigraphic age. In this paper the paleo-maps showing the continental position during Pre Gondwana, Gondwana, Early Mesozoic, Upper Mesozoic Lower Tertiary and Upper Tertiary have been prepared. The relative locations of major oil fields in the given stratigraphic age have been plotted in these maps. The geological parameters like lithological details, structural implications, petroleum generation, migration and entrapment of given spatial and temporal petroliferous system have been discussed. A complete analysis was made in relation to source rocks and reservoir rock in each petroleum system. The results are highly interesting, which are believed that through some light on the most important controlling factors of petroleum genesis. It is believed that such data are useful in the successful implementation of exploratory programs of hydrocarbons.

Implications of saline brine inclusions in charnockites of the Madurai Granulite Block, southern India

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Saline brine occurrences have been reported from many granulite terrains which are believed to be generated from the lower crust and upper mantle (eg.[1]). The southern Indian granulite terrain (SGT) has been a key area in understanding the nature and role of fluids in deep crustal processes in the past three decades (e.g. [1,2]). In the Madurai Granulite Block (MGB), a prominent tectonic block of the SGT, the role of CO₂-rich fluids in charnockitization process was proposed and supported by many early workers (e.g [3]). The present study reveals the presence of high saline brines inclusions in graphite-bearing charnockite from the MGB and its implication in the metamorphic history of the terrain.

The samples have primary and pseudosecondary monophasic carbonic inclusions, biphasic liquid/gas rich inclusions of pseudosecondary and secondary in nature and polyphasic inclusions of vapour + liquid + halite of late generations. The microthermometry confirms the presence of CO₂ inclusions from its melting temperature (T_M) ranging between (-55.7°C) to (-58.5°C). The calculated density of the primary inclusions falls in a nominal range of 0.77-0.87 g/cc which denotes slightly lesser pressure than the peak metamorphic condition of the terrain [4]. The inclusions of vapour + liquid + halite are prominent in some samples show halite dissolution temperature at 210.6°C to 443 °C from which the salinity is calculated at a range of 32.4 wt%, to 52.0 wt% NaCl equivalent. Hence it can be concluded that the inclusions are compositionally CO₂, CO₂+H₂O, CO₂+H₂O+ NaCl, with minor amounts of CH₄. The youngest generation biphasic/polyphasic inclusions identified with low CO₂ densities, total homogenisation temperature below 500 °C and the presence of halite illustrate a late stage hydrothermal activity at a lower temperature. In the field it is noted that the charnockites are retrogressed to biotite/hornblende-bearing gneisses at places controlled by fractures associated with pegmatitic veins and/or quartz veins. The presence of halite within inclusions associated with this stage suggests an influx of saline brine at the retrogressive stage. The presence of clathrates identified in samples may indicate an interaction of brine fluids and graphite to produce CO₂ - CH₄ rich fluids [4]. The immiscible nature of brine and carbonic fluids, which can persist together, even at very high magmatic temperatures, provides the explanation for the coexistence of CO₂ inclusions and NaCl-H₂O high salinity inclusions in same trails.

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Bacteria as proxies for paleo sea-level and paleoclimatic reconstruction: A Geobiotechnological perspective

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Sea-level change is an effect of climate change which alters the ecosystem and microbial community composition. Understanding the microbial community composition from the paleo records is important to predict regional climatic regime. The aim of this study is to check whether bacteria can serve as an indicator of paleo sea-level changes. Sediment core was excavated from a beach ridge at Vettaikaraniruppu (VKI; N 10° 33'20.8" E 79° 50'12.7"; 2.6Km-inland), Cauvery delta, Tamil Nadu, India. Geochronology of the three subsamples by Luminescence dating revealed the epoch of VKI-B (bottom: 24.5m) as late Pleistocene, 146.64 ± 36.81 Ka BP; VKI-M (middle: 7.2m) and VKI-T (top: 2.8m), 6.04 ± 1.25 and 3.36 ± 0.42 Ka BP respectively, as Holocene. V3 region targeted 16S rDNA metagenomic analysis of VKI subsamples revealed a total of 38 bacterial phyla. 15 phyla were exclusive for VKI-M; 1 phylum for VKI-B and none for VKI-T. Marine bacterial diversity in VKI-M was found to be increased by 81% when compared to VKI-B and VKI-T. Benthic and planktonic foraminifera were detected only at VKI-M. The dynamics of interchange of maximum and minimum abundance of marine bacterial diversity at VKI-M and VKI-B & VKI-T respectively, correlates with the paleo sea-level records of Last Glacial Maximum^[1] (LGM). Before LGM, marine bacterial communities were found to be less at VKI-B. After LGM marine bacterial communities was found to be increased at VKI-M brought about by deglaciation and subsequent marine transgression suggesting that VKI-M was a marine environment; VKI-B and VKI-T were terrestrial environments. Climate driven shift in bacterial communities before and after LGM was clearly evident from the three subsamples of VKI beach ridge. The changes in the bacterial communities of sedimentary records can be used for paleoclimatic reconstructions. Further detection of bacterial community response to climatic changes by functional genomics will provide high precision paleoclimatic reconstruction.

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Evolution of the Neoproterozoic Marwar basin: a geochemical perspective

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The Marwar Supergroup of NW India is one of the largest Neoproterozoic sedimentary successions of India. Deposited in an intracratonic sag basin, the Supergroup contains largely unmetamorphosed and undeformed fluvial siliciclastics, marine carbonates, and minor volcanoclastics which hold clues to geotectonic evolution of India subsequent to the disintegration of Rodinia and during the formation of Gondwana. In addition, owing to its continuity well into the early Cambrian, these deposits are believed to hold clues to the early evolution of animal life. In an attempt to understand the evolution of the basin, we constrained the chronology of deposition of the Marwar Supergroup by Rb-Sr dating of a tuff deposit and Sr-isotope stratigraphy of marine carbonates, and determined the provenance of siliciclastic sediments in the basin using geochemical and isotopic tracers. The Rb-Sr whole rock isochron obtained for the Choti Khattu rhyolitic tuff, located in the Jodhpur Group of the lower Marwar, constrains its age of formation to 703 ± 40 (2σ) Ma. This age indicates that the sedimentation in the basin started much earlier, in the Cryogenian, than the widely believed late Ediacaran and thus extends the duration of sedimentation to more than 160 Ma. Sr isotope stratigraphy suggests an age of 570 Ma for the Gotan Formation of the Bilara Group deposited within the middle of the supergroup. This age hints at existence of a long depositional hiatus (~ 100 Ma) between the Jodhpur and Bilara Groups. Provenance analysis using Neodymium (Nd) isotopes and trace elements shows that whereas Jodhpur Group sediments were dominantly contributed by the Delhi Supergroup (~ 1.6 Ga), Banded Gneissic Complex - 2 (> 1.8 Ga) and possibly the Erinpura Granites (~ 850 Ma), the sediments in the Bilara and Nagaur Groups were predominantly sourced from the Delhi Supergroup. We propose a three stage evolution for Marwar basin with a major hiatus of 100 Ma at ~ 700 Ma.

Inner shelf environment off Kayalpattinam, southeast coast of India and its impact on the distribution of benthic foraminifera.

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To study the ecology and distribution of Benthic foraminifera, sediment and bottom water samples were collected from the inner shelf off Kayalpattinam, at 10 locations, during the months of October 2016 and May 2016. In the present study, 72 foraminiferal species belonging to 5 sub orders have been identified. The spatial and temporal distribution of the foraminiferal fauna has also been evaluated. The distribution of the fauna have been correlated with observed environmental parameters like temperature, salinity, dissolved oxygen content and pH of the bottom water; CaCO₃ content, organic matter content, sand-silt-clay ratio of the substrate.

Higher temperature, salinity and dissolved oxygen content of the bottom water and lower organic matter and higher calcium carbonate content of the bottom sediments observed during May (Summer) are suggested for an abundance of living foraminiferal population in the present study.

Case studies of Ground Penetrating Radar (GPR) applications in Engineering and Geosciences

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Ground Penetrating Radar (GPR) is a non-destructive technique in near surface Geophysics. This paper reviews the critical aspects of GPR applications, methodologies and data interpretation with different case studies were carried out within India in the field of applied earth sciences and technologies. The important role of GPR is expressed by the wide applications in all disciplines such as (1) surface mineral resource evaluations (Lignite beds, Heavy minerals), (2) archaeological investigations (detection of tunnels, artefacts), (3) coastal sedimentary archives (paleochannel delineation, dune morphology), (4) bed rock mapping, (5) engineering non-invasive testing (fracture detection, buried pipes/objects detection), (6) well pad stability studies (land subsidence), (7) moisture evaluation in the shallow subsurface, (8) hydrogeological investigations (delineation of groundwater table) and (9) methane ebullition studies from peatlands. In brief, we have employed GPR for in-seam imaging of lignite beds of open cast mines of Neyveli Lignite mine. In coastal sedimentary environments of East and West coast of India, we have studied the internal features of a sand dunes, are significant to reveal groundwater condition and nature of deposits. In fact, paleochannels delineated in the sand dunes are sensitive pockets of heavy mineral deposits. Three dimensional data acquisition were conducted for fracture detection within the civil structures. An analogous time series of 100, 200 and 400 MHz GPR antenna's reflections were acquired in both 2D and 3D, and the mode of data collection either by common offset or common midpoint (CMP) method. The data collection parameters are depending on the purpose of study by selecting suitable parameters like depth of investigation and dielectric constant of the medium. In the conclusion, it is always to remember that the success of near-surface geophysics, as both a scientific field and technical area, is heavily rely on the collaborative and smart use of multiple types of observation techniques to eliminate the non-uniqueness of geophysical detection, to reach the ultimate goal to provide the best possible constraints in subsurface characterization and imaging.

Testing and analysis of drinking water quality in Irinjalakuda, South India

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With a view to study the sanitation condition of drinking water in certain areas of Irinjalakuda and to provide scientific bases for drinking water quality improvement and promoting public health. Water quality was tested and analyzed using the methods recommended in the WHO drinking water quality guidelines, inclusive of sensory characteristics, physico-chemical and general chemical indicators as per APHA 2012. The thirteen parameters were evaluated for water quality and compared with existing drinking water standards. The results were in the normal ranges for eight wells indicating that the water is fit for human consumption. Two samples show high levels of acidity, turbidity, salinity and chlorides, making the water unfit for human use. It was concluded that drinking water (well water) in certain areas of Irinjalakuda was slightly polluted. The wells were contaminated by dirt and silt accumulation, from nearby paddy fields hence showing high levels of the above parameters making the water unfit and grievously affecting public health.

A Factor analysis of Morphometric Parameters

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Factor analysis is the statistical methods to get the correlation and variance between the multi components and their relationship with observed components. For the present study, factor analysis of chittar watershed is carried out. The Chittar river is a major tributary of Tambaraparani river and it originates from the Courtallam hills in the Western Ghats of the Tirunelveli district, Tamilnadu. Geographic coordinates are lies in between the 77° 9'1.818" E and 9° 12' 5.488" N to 77° 48'1.15" E 8° 48' 58.169" N. The total area of the watershed is about 1600 Sq.km and its travels distance of 78 kilometers to join in the main river of Tambaraparani. Climate is distributed from humid to semi-arid. The average temperature varies between 25 °C to 41 °C; average annual rainfall is about 680 mm. In this watershed nearly 70 % of land is agriculture area. Chittar watershed belonging to 7th stream orders basins. This has been divided into 28 subbasins such that each subbasin has stream orders of three and above. The area of subbasins varies from 1.5 sq.km to 284 sq.km and stream orders vary from 3 to 6. The morphometric parameters consider for this study includes the Total stream length(L_u), Mean stream length (L_{sm}), Mean bifurcation ratio (R_b), Basin Relief (B_h), Relief ratio (R_h), Ruggedness number (R_n), Drainage density (D_d), stream frequency (F_s); Elongation ratio (R_e), Circularity ratio (R_c), Form factor (R_f), Texture ratio (T), Length of overflow land (L_g), Constant channel maintenance (C) for all 28 subbasins. The drainage network of the chittar watershed are digitize from Toposheet of scale 1: 50000. Digital Elevation Model from Cartosat-DEM of 30 m resolution is used to develop Slope as well as Lineament maps. Soil map is developed from National Bureau of Soil Survey and Land Use Planning dataset. Geomorphology and LandUse/LandCover maps are prepared from satellite imagery. Lithology map of chittar watershed is prepared from central water commission's India-WRIS dataset. Factor analysis is carried out for the 28 subbasin to compute the total variance in 15 morphometric parameters. Out of the 15 parameters only three parameters have eigen values greater than one. The Factor 1, Factor 2 and Factor 3 describes about 53.49 %, 19.06% and 10.4% respectively. These three factors explain nearly 82 % of 15 components so you can considerably reduce the complexity of the data set by using these components, with only 18% loss of information. Rotated component matrix helps you determine the highly correlated component present in those three factors loadings. They are positive and negative loadings occurred in between three factors. Thus findings of high correlated loading factor has identified the relationship of components terminate the specific character load on single factor loadings. In the Factor 1 components have positive loading such as Drainage density (D_d), stream frequency (F_s), Relief ratio (R_h), Ruggedness number (R_n). The factors Length of overflow land (L_g), constant channel maintenance (C) are negative loading with Factor 1. The parameters in Factor 1 generally contribute the drainage characteristics and runoff conditions. In the Factor 2 components have positive loading such as Elongation ratio (R_e), Circularity ratio (R_c), Form factor (R_f). This Factor 2 generally defines the areal aspects and shape characteristics. In the Factor 3 components have positive loading such as Total stream length (L_u), Mean bifurcation ratio (R_b), Basin Relief (B_h), Texture ratio (T); this factor generally explain the characteristics of "basin magnitude" as with the increase of the basin area. The findings of various characteristics in each factor are separate out for all 28 subbasins by means of factor scores. Factor scores are determining the out of three factors which has highly contributed level in every subbasin. The sub basin likely 1,2,3,4,8,16,18,24,25 and 28 are loaded in Factor 1; The sub basin whereas 7,9,10,13,14,17 and 20 are loaded in Factor 2. The sub basin likely 5, 6, 19, 22, 23, 26 and 27 are loaded in Factor 3.

Seawater intrusion: Assessment and Mitigation Measures

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Seawater intrusion is a major problem affecting the quality of precious coastal groundwater resources. It is important to precisely assess the regions affected by seawater intrusion by application of several traditional and modern tools. To overcome the problem of seawater intrusion recharge needs to be increased. A case study on the application of various investigation techniques and 3-D variably saturated groundwater flow modelling that was carried out in the Chennai region, India. This paper presents the outcome of the study.

Application of Geomatics in Water Resources Management

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Accurate monitoring and assessment of our water resources is necessary for sustained water resource management. This paper focuses on the impact of Geospatial technology which makes the determining of strategic plans and sound management practices for the identification of geographic distribution and the extraction of these resources. The three main tools under Geospatial technology: Remote Sensing (RS) Global Positioning Systems (GPS) and Geographical Information Systems (GIS) make it possible to observe remote and inaccessible places thus making accurate determination of water boundaries and surface areas, mapping of flood and flood plains, coastal zone management. Being a powerful and effective tool for developing integrated information from geographic features, environmental and social data attributes, GIS impules several hazard mitigation planning that includes the delineation of drought risk areas through the analysis of interrelated parameters which are essential in ensuring aspects of public safety, protecting against adverse drought related agricultural impacts, and safeguarding property. Integration of remote sensing with GIS supported the identification of potential groundwater zones and found to be helpful in better planning and management of groundwater resources. Artificial Ground water recharge is an effective method for ground resource development and management. Accurate and good quality Digital Elevation Model (DEM) generated from optical based sensory Cartosat data and microwave based SRTM data proved more accurate watershed delineation. The drainage map from Cartosat-DEM dominated more for the specific terrain elements than that of SRTM-DEM. As an advanced step in remote sensing technology, hyperspectral remote sensing involving images that have 350 to 1200 nanometers wavelength band sensors are used to determine chemical/biological concentrations in leaves, vegetation stress and mapping the expansion of different species of plants.

Preliminary investigation on the formation of Muriyad wetlands, Kerala South India

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Muriyad wetland is the northern extension of Vembanad Kole wetland system which is classified as one of the Ramsar sites in Kerala. The southern boundary of the Thrissur Kole lands are Chalakudy River and the northern end is the Bharathapuzha River. The Kole wetland has an area of more than 50 sq km. The Manali Puzha which is the main tributary of the Karuvannoor River feeds many area of the wetland system as it flows across the wetlands to join the Karuvannoor River at Arattupuzha area. The Manali Puzha divides the Thrissur wetland system into two parts in which the southern part is known as Muriyad wetland system. Due to agricultural practice and clay mining over the terrain, the top layers of the Muriyad wetland system are highly altered and dynamically changing. This wetland system is located 7 Km orthogonally to the present coast line. Marine marginal zones are most susceptible to geomorphic modifications. Study of the sequential data set enables clear understanding of the changes that an area has undergone. To study the formation of Muriyad wetlands twelve vibra core samples were taken up to depths of 15 meters. The samples were analyzed for textural and geochemical investigations from top to bottom. The geochemical investigation revealed that the concentration of Iron, Phosphorus, Silica, Sulphur and Calcium carbonate attains maximum values at a depth of ~ 7 meters. It also found that at a depth of ~ 7 meters from the surface, fine beach like sands seen throughout the wetlands system. The general Stratigraphy of the Muriyad wetlands derived from core samples indicate that the top layers up to a depth of 4 meters are sticky black clay. At the depth of 5 meters the Stratigraphy changes to grayish sticky clay. The bottom of the grey clay changes to the yellow fine grained sand at a depth of 7 meters. The sand layer continues to a depth of 10 meter and then again the black sticky clay appears. That clay layer ends up in again at a sand layer at a depth of 13 meters in the middle portion of the wetland system. In the NE part of this wetland a different stratigraphic set up is observed. At a depth of 5 meters from top, a layer of coarse angular sand particles observed. The texture shows that the sediments are of fluvial origin and under gone fast transportation. The sorting of clasts and geochemical characteristics of sediments highlight the depositional history of this wetland system. Evidences indicate that the deposition has taken place in a calm lacustrine or a shallow marine system.

Distribution and statistical aspects of Ostracoda: Implications on (palaeo) environment and hydrocarbon potential of the sediments

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Ostracods are bivalved tiny Crustaceans; inhabit almost all types of aquatic environments. They are found in freshwater and athalassic habitats ranging from temporary ponds, rice fields to rivers and deep lakes. Brackish water environments such as coastal saline lakes, coastal lagoons, mangrove environments and open estuaries also support a diverse range of these fauna. In the oceans, ostracods inhabit all environments from intertidal zones to open ocean depths up to 4000 meters (psychrospheric forms). Certain freshwater ostracods can tolerate extreme environmental conditions of flourishing in hot water or sulphurous springs. Ostracods have several advantages since they cover the entire Phanerozoic time scale and occur in all aquatic environments down to abyssal depths in the oceans. Salinity, water temperature, stability of the substrate and organic material are the major factors governing ostracod distribution in estuarine and shelf environments. Ostracod species diversity decreases very rapidly when water salinity exceeds 40‰. Ostracods are almost absent in coarse substrates of active hydraulic process such as wave turbulence whereas in finer substrates rich in organic detritus they form nearly large populations.

During the last four decades, the application of statistical data on Ostracoda, such as juveniles and adults; closed and isolated valves; males and females; right and left valves; smooth and ornamented forms, etc., besides colour variation, pyritisation and predation, to interpret the environment of deposition, rate of deposition and to assess the potentiality of sediments as source rocks for hydrocarbons has attained importance. The carapace of few ostracods has smooth surface, and devoid of any sculpture. However, in many species, the carapaces are with simple to complex surface ornamentation. Hence, surface ornamentation serves as direct evidence for ecological interpretations, which can be studied with the help of Scanning Electron Microscope (SEM) photographs of the specimens. Individuals living in carbonate reef environments have much thicker secondary ornamentation compared to individuals living in other environments. Ornamentation also reflects on the grain size of the sediment. Ostracod carapace-valve ratio helps in deducing siltation (sedimentation) of an area. The usage of carapace-valve ratio to yield palaeoecological information was pioneered ^[1, 2] and utilized to interpret the potential for the information of hydrocarbons, further summarized that when the ratio is high, the sedimentation is rapid, which minimizes disarticulation of carapaces into separate valves. With sufficiently rapid burial, organic matter is not absorbed by mineral particles and so retains potential for conversion into hydrocarbons. A high percentage of carapaces in the sediments of Eocene/Oligocene from southeastern Australia and India ^[3], indicate rapid burial. While studying the Tertiary Ostracoda from the Lindi area, Tanzania, Ahmed *et al.* ^[4], on the basis of carapace-valve ratio, observed a higher rate of sedimentation in the Upper Eocene and Lower Miocene than the Oligocene sediments. A very high rate of sedimentation in the Mullipallam creek, near Muthupet and Pulicat lagoon is noticed through the carapace and valve ratio of Ostracoda ^[5, 6]. Since the siltation is more in the Pulicat lagoon, periodically desiltation and dredging activities are being carried out at the mouth and middle portion of the lagoon. The implications of the proxy Ostracod surface ornamentation; carapace

and valve ratio and other environmental interpretations from these two areas are presented and discussed in this paper.

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Hunt for the Early Silicate Earth Differentiation Signatures

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Early silicate Earth differentiation essentially refers to the differentiation events of the bulk silicate earth (BSE = Bulk Earth – metallic core) during the first 500 million years of the Earth's history (Hadean eon). The $^{147,146}\text{Sm}$ - $^{143,142}\text{Nd}$ systematics is the best proxy to extract important information about these early events. This is particularly exciting because the terrestrial rock record is limited to Archean but the insights about terrestrial Hadean mantle can be obtained using ^{142}Nd isotope study of the non-Hadean rocks. These signatures are in the form of anomaly in ^{142}Nd isotope composition of the rocks, with respect to a terrestrial standard in μ notation; $\mu = (((^{142}\text{Nd}/^{144}\text{Nd})_{\text{rock}} / (^{142}\text{Nd}/^{144}\text{Nd})_{\text{terrestrial standard}}) - 1) \times 10^6$; where terrestrial standard represents the modern accessible mantle of the Earth. The most interesting finding was the offset in the ^{142}Nd isotopic composition between the Earth's accessible mantle and the chondrites; where Earth's accessible mantle is 20ppm depleted [1]. This offset and the absence of any complimentary enriched signals with respect to the chondrites (in the terrestrial rocks analysed so far) led many workers to hypothesize a non-chondritic origin for the Earth [2, 3]. However, this offset is nucleosynthetic in origin and the chondritic Earth model is still valid [4]. In the light of the nucleosynthetic origin of the ^{142}Nd isotope offset between the terrestrial mantle and the chondrites, there is no longer a need for an early global differentiation event. To understand the extent of these events, more studies from different localities around the globe are needed. We contribute to this by investigating Archean as well some geologically young rocks from India. Irrespective of the geochemical reference used for the Earth, the anomalies in terrestrial rocks have been reported with respect to the terrestrial standards, restricted to the Hadean-Archean rock record [1, 2, 5, 6, 7, 8]. The only exception is Proterozoic age alkaline rocks from Khariar [9] which has been questioned [10]. We would discuss the possible reasons for the ambiguity of the results in the two studies.

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Presence of late Holocene marine records from the Kavery basin: Foraminiferal Evidences

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Foraminifera are the most important group of microfossils due to their significance in biostratigraphic studies and palaeoclimate reconstructions. They are unquestionably considered the golden proxy to indicate the presence of marine environment. The planktonic foraminifers dwell generally away from the shore, in an open ocean environment and occupy a range of depth as they tend to be floaters and need calm environment, whereas the benthic foraminifera are the bottom dwellers, and form the main components of the shallow water carbonates. In this research article, we provide foraminiferal evidences for the presence of marine records in parts of Kavery delta. The sediment core for the study was collected from Vettai Karan Irruppu(VKI) (N 10° 33.208' / E 79° 50.127'), located in the Kavery delta, 2.6 km onshore from the present coast of Tamil Nadu, eastern India. Detailed micropalaeontological study of the core showed the planktonic and benthic foraminiferal presence at a depth of 5.6m to 10.9m down the VKI core from the ground surface, evidently indicating the presence of marine sediments in the geological past. The planktonic percentages varied from 30% to 60%, which is unlikely to get in the beach or marginal marine environment. The total organic matter of the marine sediments was calculated to be as high as 2% to 4%. Apart from this, the sediments were dominated by silty clay, serves the best suitable setting for the foraminiferal presence and preservation. The chronological framework for the marine deposition in the study area was established by Optical Stimulated Luminescence(OSL) chronology, suggesting the marine sediments were deposited between 9.27 ± 1.22 ka to 6.04 ± 1.25 ka which coincides with the global humid period that prevailed over the Northern hemisphere during late Holocene. Based on these scientific indications, we confirm the presence of marine waters between 9.27 ± 1.22 ka to 6.04 ± 1.25 ka, reaching up to ~3 km onto land from the present coast of Tamil Nadu. The occurrence of marine deposits at a higher level than the present MSL indicates that sea level has risen higher than the present MSL during Mid Holocene transgression.

Exploring Martian Geology using Remote Sensing and GIS

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Mars is one of the fascinating planet after earth, by its colour, surface features, presence of water content etc. Vast majority of the information about Mars such as its interior, atmosphere, topography and processes etc. came from several mars mission that started in late 20th century [1]. New era of exploring Mars through remote sensing observation started with Mariner 4, which took the first close-up picture of the planet [1]. Twin VIKING missions following Mariner series provided the first global image of Mars and concrete ideas about the surface features on Mars, its similarity to the features Earth. Martian surface features include outflow channels, volcanoes, canyons, craters, chaotic terrain, fretted terrain, sand dunes, glaciers, brain terrain, dark slope streaks, layerings, yardangs, gullies, deltas etc. [1,2, 3]. There are many other recent missions to Mars like Mars Global Surveyor (MGS) Mars Odyssey, Mars Express, Mars Reconnaissance Orbiter, Mars Orbiter Mission (MOM) etc that have provided data in high spatial and spectral resolution, thus significantly enhancing the understanding about Martian geology.

The Martian data, documented in Planetary Data System (PDS) format, is made freely available to the researchers, can be imported, georeferenced to Martian coordinate system and the details about the Martian surface features can be obtained by studying the morphology, topography and mineralogy using software like ENVI, JMars, Google Mars ARC map GIS etc. The altimetry data of Mars by MOLA [4], the instrument on board MGS allowed generation of digital elevation model of the entire Martian surface and allowed to visualize the Martian dichotomy, and also to map the surface feature such as volcanic terrain, canyon systems, outflow channels and river networks etc. Mapping and identification of these different features and their morphological studies such as transverse profile generation from topographic data, identification of deepest point and top of valley walls and longitudinal profiles etc can be done using such GIS based platforms[5]. Age determination is done based on crater counting, for each crater count area, all the available data are included in a data base in the Arc map GIS environment [6]. The global mosaic of TES on board MGS, THEMIS on board Mars Odyssey provide a regional mapping of Martian surface features. Mars Orbiter Cameras (Narrow-Angle, MOC-NA and Wide-Angle, MOC-WA) on board MGS[7,8], Mars Express HRSC image[9], CTX[10] and HiRISE[11] images on board MRO allow geological mapping with increasing detail. Thermal emission measured by the TES instrument helped in understanding the regional-scale mineralogy and physical characteristics of the Martian surface including the polar caps [12, 13]. Mars Odyssey THEMIS data allowed mapping of surface mineralogy and rock composition, thermal inertia, rock abundance etc [14, 15]. Hyperspectral and multi spectral data from CRISM on board the Mars Reconnaissance Orbiter, and Omega on board ESA's Mars express allow the scientist to determine mineralogical compositions. [15-20]. The above data allowed mapping of minerals such as phyllosilicates, sulphates and iron oxides on the Martian surface, which strongly support the aqueous environment in the geological past and provided clues to the changing climatic condition and lead to the proposition of chemical stratigraphy of Mars [16-20]. Inputs from the remote sensing data have provided clues to plan the Lander and rover missions to Mars which provide ground truth to the details derived from remote sensing, thus enhancing the understanding about Martian geology.

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Shalbatana Vallis: A candidate to understand the valley network formation and palaeoclimatic condition in Mars

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Mars is the only planet other than Earth showing the evidence of liquid water on its surface in terms of valleys. Valley networks, Outflow channels, gullies represent linear shaped valleys carved by flowing water on the martian surface during early history of the planet i.e., Noachian to early Hesperian [1]. Outflow channels are linear depressions, tens to hundreds of kilometers across, generally containing tear-drop shaped islands of preexisting terrain [2]. Most lack tributaries and almost all outflow channels are originated from the chaotic terrain, which lead to a theory of megaflooding events due to catastrophic and non-catastrophic release of pressurized ground water system [3]. Seismic activity from a large impact event, pressurized groundwater system, igneous intrusion etc could have lead to the catastrophic release of water from frozen cryosphere, leading to chaos formation and further out flow [4]. Shalbatana vallis is an ancient outflow channel on Mars, located in Oxia Palus quadrangle at 7.8 N latitude and 42.1 W longitudes. It is in the western most of the Southern Chryse outflow channel. The valley is about 1300km long with width reaching upto 20 km and drain to north into Chryse Planitia basin. The vallis originates in a linear depression resembling a chaotic terrain north of Ganges Chasma and west of Ravis Valles. The channel becomes well defined after an intra-valley palaeolake with a depth of over 400 m, in the 125 km diameter Orson Welles crater at 1.75° N, 43.55° [5]. The geologic history of this area has significant implications for understanding Mars' palaeohydrologic and climatic conditions. This valley is considered to be active from Noachian up to late Hesperian – early Amazonia [6]. Unlike other outflow channels in Mars, Shalbatana vallye is narrow (with ~20km) and much deep(>2 km) at its origin itself. The narrow width might be suggesting tectonic influence over the formation of the vallis. Different mechanisms have been hypothesized in order to account for the water discharges of Shalbatana Vallis ranging from faulting and magmatic intrusion leading to hydrothermal drainage of confined aquifer [7]; internal drainage from Ganges Chasma [3], water released by Noachian impact in the headwater region [8]. Apart from its origin, Shalbatana Vallis also shows features such as Martian shoreline, presence of palaeolake, gilbert type delta [1], [9] and evaporite deposits in the deepest part of the valley suggesting post-valley formation evolution due to changing climatic conditions. Analysis of CRISM data showed enrichment of hydrated minerals associated with the lacustrine bed is found, the presence of the mixture of Fe, Mg, and Al phyllosilicates polyhydrated sulfates and secondary opal are associated with it. Influence of climatic condition in these system is uncertain sometimes it may accelerated by secondary regional factors volcanism, impact cratering or tectonism. However Shalbatana vallis and associated palaeolake is a new insight for Martian history and the deltas may be a key for its biological past, if it is existed.

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Recent advances in stable isotope hydrology studies over India: Implication to paleo monsoon reconstruction

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Stable oxygen isotopic ($\delta^{18}\text{O}$) variations of proxies (e.g., cellulose of annual growth rings of trees¹ and cave calcites²) of past precipitation are decoded mainly using the significant negative correlation between the amount of monthly rain and its $\delta^{18}\text{O}$, known as the ‘amount effect’. This effect is observed³ in the tropics as typically $\sim -1.5\text{‰}$ per 100 mm increase in the monthly precipitation. There is, however, a large spatial variation⁴, because of varying cloud condensation processes and their interaction with ambient atmospheric moisture. And at some sites (especially North-East and peninsular India), the rainfall proxies are not interpretable by this effect. From $\delta^{18}\text{O}$ analyses of ~ 654 samples of daily rain collected during summer 2012 across 9 stations in Kerala, southern India, we show here that relatively higher ^{18}O -depletion in monsoon rain is not related necessarily to its amount, but rather, to large scale organized convection. This is further confirmed by the analysis of the spatial pattern of clouds using Outgoing Longwave Radiation and the Tropical Rainfall Measurement Mission derived rainfall. Thus paleomonsoon proxies such as teak tree cellulose from Kerala may be interpretable in terms of the degree of large scale convective activity during the summer monsoon rather than the amount of monsoon rainfall.

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Luminescence Chronology of Fluvial records from Gingee, Then-Pennai, Vellar and Palar Rivers in Tamil Nadu, India.

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Fluvial system are continental records response swiftly to tectonics or climate changes. Palaeofloods are one of these preserving the intense precipitation events usually associated with climate changes. In order to predict the floods or to get the recurrence interval beyond historical or instrumental records, a precise chronology is required. C-14 is widely used in such system however, lacks of datable material i.e. organic material in such a system is a challenge. Luminescence dating is another popular method dating the event of last daylight exposure of the sediment and the minerals used for dating are Quartz and Feldspar, a ubiquitous mineral in almost all the type of sediment. However, the partial or heterogeneous bleaching of sediment poses a problem in young sediments. Gingee, Then Pennai, Vellar and Palar makes fluvial system of eastern Tamil Nadu. These rivers are ephemeral in nature ranging in length up to few hundred kilometres only flowing through the Cuddalore sandstone and so the chances of mixing of unbleached weathered sand grains from the local rocks are very high, even more as the distance of transport is short too. Here we test the feasibility of luminescence dating in such a system in the high energy fluvial deposit where partial bleaching could be high. We have also chosen a well-known high flood event recently happened in Chennai during 10-14 November, 2015 for sampling and to check the partial bleaching. Most of the samples have shown partial bleaching and even the application of various models suggested by Lee and Arnold, may not be successfully applied in some of the cases. Here we present the results of OSL dating of sediments from Gingee, Then-Pennai and Vellar Rivers and also provide past flooding records from these rivers. In Gingee River, channel sand is dated to be 330 ± 20 years BP overlain by 6 units of past flood deposited in 60-70 years BP. It shows a dry phase during 330-60 years BP. Similarly two slack water deposit in Palar River are giving an age of 60 ± 10 years. It seems that 60 years BP, there were several flooding events in entire Tamil Nadu region of the country as also confirmed from the famous Kaveri flood happened in 1961. It shows a successful application of OSL dating to such a system at the centennial scale.

OSL Dating of Coastal Sediments

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Optically stimulated luminescence (OSL) dating of sediments was proven to be a powerful tool for the reconstruction of Holocene coastal landscape dynamics. In my presentation I will show you in a short review three case studies from Northern Europe. The history of Holocene sea-level change and sediment accumulation along the German North Sea coast is controversial because of a limitation in the quantity and quality of chronological data [1]. Therefore, to shed some more light into the chronological framework, a 16-ka coastal sedimentary record from northern Germany was studied using OSL and AMS ¹⁴C dating techniques [2]. The robust chronology using 14 radiocarbon and 25 OSL dates was the first long-term record that covers the Holocene as well as the last deglaciation period in one succession providing new insight into understanding the Holocene transgression and coastal accumulation histories up to the 11th century when humans were around and diking activities started in the study area. In order to test the accuracy of quartz optically stimulated luminescence (OSL) dating for young dune sediments (<100 a), aerial images of a migrating sand dune was used to cross-validate OSL ages. The investigated dune is located in the very northern part of Germany on the island of Sylt. Based on aerial images and a map covering the years from 1925 to 2009, and the internal architecture of the dune obtained by ground-penetrating radar (GPR), an independent age model was set up to attribute sedimentary-architectural elements of the dune to time [3]. The annual rate of dune migration was around 4.1 m/a. The oldest OSL age from the investigated recent dune appeared to be 110±10 a, whereas the modern analogue was dated to 34±3 a. In comparison with the exactly dated aerial images, the OSL ages show systematic overestimations of 10-40 years for six out of seven samples expected to be younger than 60 a. This offset is negligible for older samples, but substantial for younger samples. Sandy spits on the Świna barrier in northwest Poland provide a very detailed succession of Holocene coastal foredunes and dunes along the southern Baltic Sea coast [4]. Quartz extracted from the coastal sediments have excellent luminescence properties. The OSL age from the innermost dune indicates that spit development started immediately after rapid sea-level rise (Littorina Transgression) decelerated at ~6.6 ka. A significant change in the foredune progradation rate occurred during the late Subatlantic transgression at ~1.2 ka (800 AD), when migration rates decreased from 2.6±0.7 m to 1.3±0.4 m/a. Progradation accelerated again during the “Little Ice Age” between 1550 and 1850 AD. The period of increased aeolian activity around 1000 AD is probably to a phase of intensive forest clearance in Central Europe.

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Philosophies for palaeosciences: a mini-review by a quasi-expert

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Palaeosciences may mean literally **to know the past** (palaeo - old; in *Greek* - *palaio* and science - to know; in *Latin* - *scientia*). This can be better studied with a cross disciplinary approach and it bring the philosophical issues in communicating to each other. The classical conflict between historical sciences and non-historical sciences (natural experimental sciences) will arise when the objective is to reconstruct the past life, ecology, climate, etc. This can be reflected in publishing and evaluating palaeoscience research articles in science journals. This article is mainly reviewing the conflict between the historical sciences and natural experimental sciences by finding the resemblances and differences between them.

Scientific realism, not empiricism, seems to capture the ontology of historical sciences as palaeoscientists are dealing with the definite past which is unobservable. They not only work in present time to observe the phenomenon and the formal relationship among the observables but also formulate theories to understand the causal relationships. Although the information about the past fades or decays due to the information-clearing processes, palaeosciences take advantage of over-determination of causes by the effects whereas the natural experimental sciences suffer by the under-determination (Duhem-Quine thesis) of the theory by the evidences. In this sense, epistemologically palaeosciences stand equal to, if not superior to, natural experimental sciences. Considering its complex nature (multiple processes are working with different frequencies), applicability of Occam's razor principle may not be applicable as a guiding principle. Even the metaphysical requirement of uniformitarianism principle might not hold indefinitely for the deeper past as that is dependent on the kind of processes (physical, biological or anthropological) which is being interpreted.

There are discussions about whether the palaeosciences can be called special sciences which assumes physics as general science. This means physics is the lowest level science and chemistry, biology, ecology, sociology, economics, etc have supervenience relationship with the fundamental physics through the emergent entities. Further, if the Popper's falsificationism is applied in strict sense the palaeoscience can't be demarcated to be science but pseudo-science. Few studies are there which suggest the palaeosciences to be seen as both idiographic and nomothetical rather than either or. Few other studies suggest that the palaeosciences to be more pragmatic rather than be struck up with logical constraints. That is because palaeoscientists are like detective agents or forensic scientists who have to follow all the available means (not only 'scientific' methods) and evidences/traces to identify the real cause. This seems to be like Feyerabendian approach (anything goes!).

Democracy in science or the sociality of science is the quest for a long time and the palaeosciences can offer a unique opportunity towards that through the citizen science concept and standpoint theory. Assuming the purpose of palaeoscience is to look back to the future through the present, present can't be understood without the knowledge of the local people by discriminating them by gender or caste. Although science is objective - independent of who does it - situated knowledge of these subjugated people makes the objectivity maximized. Details of each points above will be discussed in the conference.

Sample size dependent OSL age: results from Ladakh, India

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The quartz from Himalayan and Alps region are 'dull' in terms of luminescence response to the radiation dose whereas those from Peninsular India and Australia are 'bright'. The reason for this phenomena is yet to be understood. Generally, to overcome the problem of dating dull grains like this, it is reasonable to make bigger aliquots (sub-samples) so that sufficient photon counts are measured from the sample. Increasing aliquot size will put serious limitation if the grains were heterogeneously bleached upon deposition. Although single grain dating was suggested to isolate well bleached grains from the poorly bleached grains, the dullness of the quartz would make this approach extremely costly in terms of machine-time. So a striking balance need to be achieved while making aliquots with sufficient number of quartz grains. That balance depends on the degree of heterogeneity of bleaching and the 'dullness' of quartz grains. This study investigates to find out whether a right balance can be achieved or not, if yes, then what should be the size of the aliquot. Seven samples were used for this investigation in such a way that six samples were from trans-Himalayan region which were already having ¹⁴C (AMS) ages and one sample from Krishna river delta as a 'control sample' (KD 03) in terms of well bleachedness and brightness. We made 3 types (~ 1000 grains - bigger aliquot, BA; ~ 500 grains, MA and ~ 100 grains, SA) of aliquots from each sample and measured palaeo-dose from each of these types. The spread (over-dispersion, OD, %) in the data was observed to be increasing from BA to SA via MA whereas the palaeo-dose was showing a decreasing trend. Both these trends were not observed in KD 03. Single grains were not yielding any positive results and the acceptance rate was much less than 1 grain/100 grains. The ages from bigger and medium sized sub-samples (BA and MA) are over-estimated compared to the ¹⁴C ages. It was found that the degree of heterogeneity decides the size of the sub-sample to get reliable OSL estimate and more details will be presented in the conference.

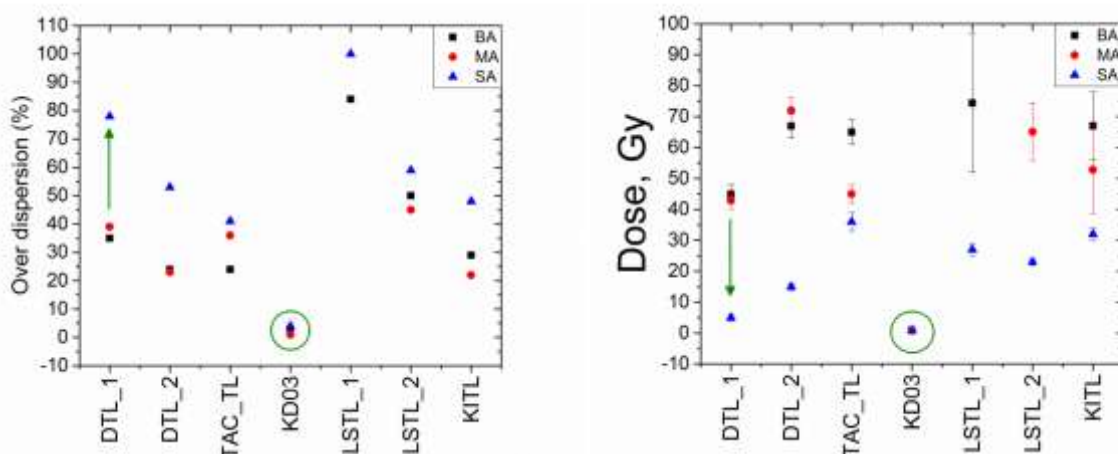


Figure: Over-dispersion (%; spread in the data set) and the palaeo-dose (Gy) of 6 samples (quartz extract) using 3 types of sub-samples (aliquots). KD03 (circled one) is the control sample where no variation in the spread and in the palaeo-dose. Arrowed line indicate the increase/decrease in the spread/palaeo-dose respectively.

A Preliminary Report on the Spectral and Chemical Characterization of Magnesite in Bhavani Shear Zone, southern India

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Magnesite (MgCO_3) mineralization in ultramafic rocks has globally been attributed to the serpentinization process, to later metasomatism of the serpentinite, or to near-surface meteoric weathering of the ultramafic bodies. Although the source of magnesium in magnesite may be derived from the magnesium-rich minerals (olivine and pyroxenes) within the ultramafic host, the source of carbon is unclear. The source of carbon may be atmospheric (including plant respiration and degradation), volcanic, or metamorphic (degassing). Magnesite mineralization is observed in various suture/shear zones in southern India closely linked to post-magmatic alteration of ultramafic rocks. We present here the preliminary results of our chemical and spectral studies on magnesite mineralization in Attappadi region in northern Kerala. The Attappadi valley, in northern Kerala, represents the western termination of the ENE-WSW trending Bhavani Shear Zone in southern India. The magnesite mineralization in Attappadi occurs within peridotites/pyroxenites as veins and veinlets measuring a few mm to 30 cm, in width. The position and shapes of absorption features observed in hyperspectral characterization are a function of the molecular bonds present in the mineral. The carbonate minerals produce distinctive spectral absorption feature in the SWIR region, including the main diagnostic CO_3 absorption feature located between 2300 and 2350 nm. The Attappadi magnesite samples have an absorption band at 2305 nm which is closely associated with the specific absorption band of Mg-rich carbonates (2302 nm). An absorption band at 1900 nm is indicative of small amounts of water present as fluid inclusions in magnesite, a common feature noticed in other reported magnesite. The d values of the samples from X-ray Diffraction analyses are closely comparable with the pure magnesite data reported in mineral libraries. The prominent peaks corresponding to the standard d values of magnesite, i.e. $2.728\text{\AA}$ ($2.727\text{\AA}$), $2.095\text{\AA}$ ($2.102\text{\AA}$) and $1.696\text{\AA}$ ($1.700\text{\AA}$) are observed in Attappadi samples (the values in parentheses correspond to pure magnesite). Our ongoing studies on mineral chemistry and stable isotopes will provide a comprehensive genetic mechanism of magnesite mineralization in Precambrian Attappadi region.

Geochemical Anomalies on the Moon

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The data from various orbiter missions of moon has allowed mapping of photogeological as well as elemental abundances on the lunar surface. The data from Gamma ray spectrometer on board Lunar prospector mission, Clementine data and recent Chandrayaan -1 mission have provided clues to the lunar surface composition. The above missions have showed presence of several geochemical anomalous regions on the lunar surface, particularly on the eastern limb side and lunar far-side [1]. Geochemical anomalies are found when a certain area will have unusual abundance of particular element with respect to usual concentration of the element in its surroundings. Understanding the geochemical anomalies of farside will help to achieve a better understanding of geochemical history of the moon. The major anomalies in the farside are found in Balmer basin, Terrain north-east of Mare Smythii, Near Langemak crater, Pasteur crater, Terrain northeast of Milne basin, Northeast of Mendeleev basin, North and northeast of Korolev basin, Terrain north of Taruntius crater, Terrain north of Orientale basin, Dewar crater, Mare Marginis and Van de Graaff crater, Compton Belkovich etc [2,3,4,5]. Many of these regions show anomaly of similar kind. High thorium abundance is found in some of them, namely Van de Graaff crater, Balmer crater, northeast of Smythii mare whereas regions near Pasteur crater, northeast of Milne basin, east of Mendeleev basin and Korolev basin do not show much of radioactive anomaly. Most of the regions having high TiO₂ anomaly are associated with high FeO anomaly like Dewar crater, Balmer basin, Langemak crater, Mare Smythii, Milne basin, except north of Orientale basin, where high TiO₂ is associated with low FeO values and Van de Graaff region, where Fe is high, but Ti abundance is low.[2,1,4]. Study of Compton- Belkovich anomaly has revealed a late stage non-mare -silicic volcanism on far-side of the moon [5] Most of these anomalies are related to Imbrium-Nectarian craters, formed due to extrusive volcanic activity. They are quite commonly found to be associated with dark-haloed craters formed when mare basalts are covered with highland debris, where basaltic units are contaminated due to mixing of highland material. In case of anomalies associated with simple mare basalts without any dark haloed craters, the origin is not very well known. Heterogeneity in the lunar magma ocean during its crystallisation process might have led to some anomalies [2]. It might also provide hint to the late stage non-mare volcanism activity [5].

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Investigations of factors responsible for changes in Luminescence Sensitivity of Quartz

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Variations in luminescence sensitivity of mineral quartz and its enhancement during repeated recycling have always been a challenge for understanding the mechanism of luminescence phenomenon. In this work, we made a systematic effort for improving the understanding of processes involved in sensitivity enhancement and tried to identify the factors responsible for it. The initial thermoluminescence (TL) and optically stimulated luminescence (OSL) curves of samples with variable sensitivities were measured, their constituent components were identified, and correlated with their respective sensitivities. The controlled laboratory experiments involving thermal annealing, irradiation and light exposure were performed to examine the role of mentioned laboratory treatments on the TL or OSL curves and their components. The experiments suggested that quartz OSL sensitivity can increase due to thermal annealing and sunlight exposure. High radiation dose can enhance the OSL sensitivity of samples already sensitized in nature, but did not show any effect on insensitive samples. TGA experiment showed differences in the TGA curve for sensitive and insensitive samples. The insensitive samples lost weight upon heating, whereas there is no weight loss in case of sensitive samples. FTIR measurements showed loss of water during quartz OSL sensitization and The experimental observations along with existing literature helped in identifying the possible changes in crystal lattice during sensitization.

Assessment of the water balance and morphometric analysis using remote sensing and GIS of two sub-basins

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Understanding and estimating the earth's hydrologic cycle is important to water resource planners and managers. Hence, the information on spatial and temporal availability of water will be helpful for the optimum utilization of water resources. The water balance was used for computing seasonal and geographical patterns of water availability to facilitate better management of available water resources. The water balance study using the Thornthwaite and Mather (TM) model with the help of remote sensing and GIS is very helpful in finding out the periods of moisture deficit and moisture surplus for an entire basin. While using annual datasets in monthly basis water balance of a semi-arid location, the initial soil water storage is generally assumed to be at field capacity at the beginning of the wet season. A Soil Water Balance computer code has been developed to calculate temporal variations in runoff and groundwater recharge by using Thornthwaite and Mather method. The Soil Water Balance model calculates recharge by use of commonly available geographic information system (GIS) data layers in combination with tabular climatological data. As the study areas, Raichur and Kurnool are two dry places in southern India Monthly soil water balance study enable us to find out surplus and deficit months throughout the year.

The month of July, August and September, where the Monsoon rain is available are the only surplus years in the terms of soil moisture. Same way May is the month which shows a maximum deficit. Correspondingly Runoff and Detention also follows the same monthly sequence by showing an explicit hike from July to August followed by a lucid drop reaching minimum values in May and June. The Available water capacity calculated by Land uses, texture and rooting depth have changed in moisture values accordingly.

In this study, morphometric analysis using remote sensing and GIS techniques have been carried out in upper Tungabhadra basin, the Raichur and Kurnool district of Karnataka and Andhra Pradesh respectively. For more accurate and detailed study, we used CARTO-DEM (10 m) data as digital elevation model (DEM). GIS was employed for the calculation of linear, areal and relief aspects of morphometric parameters. Watershed boundary, flow accumulation, flow direction, flow length, stream ordering maps and its attributes have been prepared using DEM Hydro processing tool in ILWIS. Different thematic maps e.g. stream orders; drainage density, slope, and relief have been prepared by using GIS software and have computed almost 20 morphometric parameters of all aspects. The present morphometric analyses suggest the increase in drainage density with respect to change in soil texture.

Late Neogene planktonic foraminiferal distribution and their relationships to paleoceanographic changes

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The South Atlantic sector of Southern Ocean is the entry point of major deep and intermediate water masses into the Antarctic region which contributes to the global overturning circulation. Deep sea core samples from Ocean Drilling Program (ODP) Hole 1088B, Agulhas Ridge are used to reconstruct the paleoceanographic changes in Southern Ocean. The study area being highly productive, yields excessive aggregate of planktic foraminifera. The abundance of species such as *Globigerina bulloides*, *Neogloboquadrina pachyderma* and several other mixed layer species (*Globigerinita glutinata*, *Globorotalia crassaformis*, *Globorotalia inflata*, *Neogloboquadrina dutertrei*) vary according to the influx of nutrient rich upwelling water masses, glacial interglacial cycles and major climatic incidents. The abundance of dominating planktic species are correlated with $\delta^{18}\text{O}$, $\delta^{13}\text{C}$ and terrigenous inputs of the South Atlantic sector from Late Neogene to Holocene. The Miocene-Pliocene margin (~6 Ma) is marked by the emergence of *G. inflata* and increasing abundance of *N. dutertrei*. The same period exhibit an increasing trend in North Atlantic Deep Water (NADW) influx into Southern Ocean while *G. bulloides* indicates a fall in abundance. The Pliocene warm period (~4-3 Ma) is characterized by increasing abundance of *G. bulloides*, *G. inflata* with a decline in $\delta^{18}\text{O}$ values and NADW influx. The Northern Hemisphere glaciation (~3 Ma) is marked by increasing $\delta^{18}\text{O}$ values against the decreasing $\delta^{13}\text{C}$ values and low abundance of *G. bulloides* in particular. The Pleistocene to recent period is noticed by the increasingly fluctuating values of $\delta^{18}\text{O}$ as well as major planktic species. This Pleistocene variability is a result of glacial-interglacial cycles predominant in this period. The planktic foraminiferal abundances are altered by the contrast in sea surface temperature (SST) and oceanographic changes which infer the chief climatic events. The results indicate the Planktic foraminiferal assemblage of South Atlantic sector is an effective tool in delineating past oceanographic and climatic conditions in Southern Ocean.

Significance of petrologic P–T path and EMP monazite ages from the metapelites, Nellore schist belt, Southeastern India

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Greenschist-amphibolite facies metamorphic rocks have been identified in the Vinjamuru domain of the Nellore schist belt (NSB), Southeastern India [1]. The metapelites are typically characterized by garnet + staurolite + kyanite + biotite + muscovite + quartz + ilmenite ± plagioclase ± chlorite mineral assemblage. In this study, we present P–T pseudosection modeling and *in situ* electron microprobe (EMP) monazite geochronology that corroborate the relative timing of three distinct metamorphic episodes (M_1 , M_2 and M_3) recorded in the multiply deformed (D_1 , D_2 and D_3) metapelites of the NSB. The U–Th–total Pb chemical ages were estimated using improved EMP monazite dating technique, which incorporates multi-spectrometer U, Th and Pb analyses and sub-counting method [2]. The new approach exhibits significant reduction in the spot age error, which is helpful in resolving un-mixed age populations separated by ~100 Ma.

The monazite spot ages from representative metapelites were pooled together to construct cumulative probability curve. The un-mixing of these spot ages from polygenetic monazites yields three distinct populations at 0.80 Ga, 1.35–1.45 Ga and 1.55–1.65 Ga. The older age populations (1.55–1.65 Ga) retrieved from recrystallized quartz corresponds with the M_1 metamorphic assemblage (500–540 °C, 6.0–6.4 kb) of garnet + biotite + kyanite + quartz ± staurolite. The 1.35–1.45 Ga age populations are associated with the development of peak (M_2) metamorphic assemblage garnet + staurolite + biotite + kyanite + quartz ± plagioclase at 600–620 °C, 7.8–8.2 kb. The peak metamorphism (1.35–1.45 Ga) in pelites is largely overlaps with the extensive felsic magmatism in and around the NSB. The younger populations (~0.80 Ga) are possibly recorded during retrograde metamorphism that may have been related to the last phase of deformation in the metapelites. The inferences from the metamorphic P–T trajectory and monazite dating are correlated with the polyphase Proterozoic tectonic-thermal events [3] documented in the Rayner complex of East Antarctica.

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Instrumentation for petrology research in Kerala

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Kerala traditionally had strengths in petrological research. The initial phases of this research naturally focused on petrographic observations, due to the lack of access to adequate instrumental facilities. The available microscopes were used for detailed and professional petrographic documentation, the U-stage for fabric analyses, traditional wet chemical methods for geochemical analyses, sedimentological labs for mineral separation and study at the Department of Geology, University of Kerala and elsewhere in the state. Subsequently with the establishment of the Centre for Earth Science Studies (CESS) in 1975, the facilities for petrological research improved. The establishment of the Fluid Inclusion lab was a beginning in the move towards more sophistication in petrological research. Nevertheless high quality research was conducted and papers published through active collaborations with foreign scientists, especially from Germany, Japan, UK, USA and Canada. The lack of access to instrumentation locally was made up by these tie-ups in research. The 1980.s saw a boom in interest in the Precambrian rocks of Kerala, and in the subsequent decades several facilities for research came up. The powder XRF and XRD lab, the palaeomagnetism lab – both in the CESS, the AAS, ICP OES in the erstwhile Regional Research Laboratory, Trivandrum were major milestones in petrological research in Kerala. From those initial days of finding ones foot, petrological research in Kerala is now poised for rapid growth. This has happened through concerted efforts of the Government of India through its various funding schemes like the DST PURSE funding to universities. The University of Kerala was able to set up an ICP-MS coupled with a Laser Ablation unit with these funds. The MOES take-over of CESS lead to its renaming as National-CESS (NCESS). More than just a change of name, it lead to influx of funds and CESS is poised to make a mark in solid earth research. Several sophisticated instruments like the ICPMS, LA, EPMA, etc would be established in the NCESS, which already has state-of-the-art sample processing labs with the full range of sample comminution, thin sectioning, mineral separation (Wifley table, Franz Isodynamic Separator). The talk will discuss the details of the latest instrumental facilities available in Kerala and also the newer developments in the world of petrology as far as instrumentation is concerned.

Estimation of Rainfall recharge using Infiltration Technique in Keecheri-Puzhakkal River basins, central Kerala

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Rainfall recharge using rainfall infiltration factor in any stress period can be calculated using the normal rainfall during the stress period multiplied by area of the assessment unit and by the rainfall infiltration factor. Infiltration study was carried out in the Keecheri-Puzhakkal river basins of central Kerala, to estimate the rainfall recharge. During summer months the groundwater storage in the midland and foothill regions of the basins is depleted fast due to extensive groundwater draft using bore wells for domestic and irrigation requirements. The river basins in total have a total catchment area of 635 km² and receive an average annual rainfall of 3000 mm. The length of the mainstream of Keecheri and Puzhakkal rivers are 51 km and 29 km respectively with an annual average stream flow of 1024 MCM. A major irrigation dam (Vazhani) is located in the upstream part of the river basin. The Kole land region of the basins extends in most of the lowland region with ridge-runnel topography in the sandy coastal stretches. Geologically, lowland regions mainly consist of paleo-beach deposits, fluvial and fluvio-marine deposits. The Kole lands have a significant influence on groundwater environment in these basins. The midland region is mainly covered with Laterite and weathered Charnockites and Charnockite gneisses. The foothill areas within the basin mainly consist of Charnockites, Hornblende-biotite gneisses and Pyroxene granulite with intrusions of Gabbro and Dolerite. Infiltration study was conducted at nine locations representing various geomorphological units within the basin. The saturated hydraulic conductivity of the soil samples was also measured. The infiltration rate is found to vary from 0.71 to 2.49 cm/hr in the coastal plain region and 1.2 to 26.4 cm/hr in the midland region. The infiltration rate of the soil varied from 0.54 to 2.40 cm/hr in the foot hill areas. The older coastal plain unit contributes mainly to the rainfall recharge in the coastal plain region (3353 ham). The total annual rainfall recharge in the coastal plain region during monsoon and non-monsoon seasons is 3489 ham. The pediment-pediplain complex contributes mainly for recharge (3964 ham) along with valley fill area (1548 ham) in the midland region. The total annual rainfall recharge in the midland region of the basin is 5512 ham. The structural hill unit contributes mainly to the groundwater storage in the foothill region (3846 ham). The total annual rainfall recharge in the foothill region is 4654 ham. The total annual rainfall recharge of the river basins computed as per rainfall infiltration method is 13,655 ham.

Bioaccumulation of cadmium in the gonads of fresh water fish, *Rasbora dandia*

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Heavy metals are one of the major pollutants of aquatic environment. Property of bioaccumulation makes the hazard of heavy metal pollution more vicious. Pattern of accumulation of metals are highly variable among species. Cadmium has diverse affinity among fresh water fishes. The present study examines the bioaccumulation of cadmium in the gonads of fresh water fish, *Rasbora dandia*. The fishes were collected from koal wetlands in Manalur of Thrissur district. They were exposed to 1 ppm of cadmium for 30 days. Fishes were sacrificed and gonads were tested for accumulation of cadmium for every 10 days. Analysis of control samples showed absence of cadmium in gonads. Test fishes exposed to cadmium showed accumulation of cadmium in gonads. The results obtained indicated increase in accumulation of cadmium in the gonads with progress of the exposure period. Both, testes and ovaries showed similar pattern of cadmium accumulation.

Thermal History of Rocks

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Natural thermoluminescence (TL) in rocks reflects a dynamic equilibrium between radiation-induced TL growth and decay via thermal and athermal pathways. When rocks exhumed through Earth's crust and cool from high to low temperature, this equilibrium level increases as temperature dependent thermal decay decreases. This phenomenon has been exploited to extract thermal histories of rocks using different optical signals.

The present study aims to explore TL of feldspar. The main advantage of TL is that a single TL glow curve has a wide range of thermal stability (<ka to Ba), and hence provides multiple thermochronometers. Here we constrain the distribution of kinetic parameters of TL in feldspar using a glow curve deconvolution method and fitting of infinitesimal sub-peaks using general order kinetics. Each peak corresponds to a different but closely located energy level E .

After constraining TL growth, thermal decay and athermal decay in the laboratory, appropriate forward modeling is applied for different time-temperature histories. We test the sensitivity and limitation of each signal for different cooling rates, and predict the closure temperatures of each signal. Our results show that the closure temperature ranges from ~30 °C to ~80 °C for TL peak temperatures ranging from 220 to 320 °C. Low activation energy, or shallower traps (~250 °C TL) can be exploited to constrain relatively low cooling histories (<50 °C/Ma), whereas high activation energy, or deeper traps (>300 °C) provide constraints on thermal histories for high cooling rates (>300 °C/Ma).

The newly developed methodology is successfully applied to rapidly cooled samples from the Namche Barwa massif, eastern Himalaya, and the central Southern Alps, New Zealand.

Assessment of impact of managed aquifer recharge structures; A comparative study

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Groundwater overuse has lead to the depletion of water resources as the annual recharge is lesser than the water extracted from the aquifers. The replenishment and management of aquifers has emerged as a top priority due to groundwater contamination of aquifers. Managed aquifer recharge (MAR) methods can augment the groundwater recharge and thereby improve sustainable management of groundwater resources. The objective of the present study is to compare the effects and feasibility of three different MAR structures such as, percolation pond, check dam and dug well recharge structure in Tamil Nadu. The percolation pond was constructed in an agricultural land in an alluvial aquifer with the objective of mitigating seawater intrusion. The check dam considered for this study across Arani river is to improve the groundwater level in the nearby areas. The dugwell recharge structure was constructed in a hard rock terrain in the Dharmapuri district of Tamil Nadu to dilute the high fluoride concentration in groundwater in the area. The major source of water for aquifer recharge is rain water. The groundwater storage and quality of the nearby areas of the recharge structures were improved due to the recharge from the MAR structures. The volume of water recharged annually into the aquifer through the percolation pond was calculated to be between 250 and 300 m³. The cost of water recharged from the percolation pond works out to be about 0.225 INR/l. The volume of water stored by the check dam annually was estimated approximately as 1.7 Million m³ in which 1.14 million m³ (66%) was found to be recharged into the aquifer. The cost of 1 m³ of water recharged by the check dam is about INR. 1.20. The dugwell recharge structure has resulted in the rise of groundwater level by 5.4 m and lowering the fluoride concentration from 3.1 mg/l to 1.44 mg/l, benefiting an area of about 1 km².

Spinel-bearing Anorthosites in southern India as Probable Terrestrial Analogues to Lunar Highland Crust

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Planetary analogue research is a potential theme in planetary geosciences to make out various processes involved in origin and subsequent evolution of a planet or a rocky moon. In order to understand diverse processes on Moon or Mars, frequently the Earth's surface (morphology) and objects (like rocks and minerals) are to be compared and studied. The analogue sites on Earth provide us with resources and data that can be used as ground truth for satellites and other training purposes. Through these studies researchers can propose probable test bed sites for ISRO's Moon/Mars missions so that numerous planetary investigations can be conducted. A variety of landforms in India show close similarities with the lunar landforms and are being studied by researchers to gain comprehensive information on lunar geological processes. The highland (terrae) region of our Earth's moon is dominated by a light coloured anorthite feldspar rich rock known as anorthosite. Evidence suggests that the early Moon was covered by a magma ocean which differentiated as it crystallized, forming a plagioclase flotation crust and a cumulate pile of denser mafic minerals. Subsequent bombardment of the lunar surface has disrupted the original flotation crust, and most of the remnants have been obscured by more mafic deposits, but the distribution of the outcrops of pure anorthosite that have been identified holds important implications for the evolution of the lunar crust. The lunar anorthosites, at places, are closely associated with many magnesium rich (hereafter Mg-rich) rocks such as dunite, gabbro, norite and troctolite. The rock association indicates deeper mantle source regions for the formation of lunar anorthosites, probably as fractionated products. The Precambrian crust of southern peninsular India has many spinel-bearing anorthosite exposures which are similar to lunar highland anorthosites. Spectral and chemical characterization of these anorthosite complexes offer significant information on the chemical nature and evolution of the lunar mantle and crust. The data of reflectance spectroscopy, laser raman spectra, XRD and mineral chemistry of several spinel bearing anorthosites in Sittampundi anorthosite complex (SAC) in southern India have close similarities with lunar anorthosites. We will discuss several geological aspects and hyperspectral features of anorthosites exposed in SAC and check for its appropriateness as a probable lunar analogue site.

Foraminifera in marine sediments off west coast of India- A tool for Paleoclimatic Reconstructions

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Climate prediction is a very delicate task and needs a thorough knowledge about the past. Past records have been maintained for not more than past 100-150 years, beyond which we would need proxies to give us information about the past climate. During the past few decades, microfossils, especially foraminifers have become the prime source to paleoclimatic reconstructions. Extreme sensitivity of foraminifera to changing environmental conditions have led to development of techniques to understand the past sea level fluctuations, monsoons, cyclones and storms, using specific characteristics of foraminifera assemblages.

We have generated an updated sea level curve for Late Pleistocene-Holocene sea level fluctuations. We successfully demonstrated that as compared to the present, sea level was lower by ~100 m about 14,500 years BP (Before Present), and ~60 m about 10,000 years BP. It has been reported that since the last 10,000 years, three major episodes of sea level variation have resulted. Similarly, we have gleaned evidences that attest to higher strands of sea level ~6000 years BP. Utilising the sea level curve and occurrence of foraminifera (exclusively marine microfossils) it was conclusively established that the rectangular structure at Lothal (a Harappan Settlement, near Ahmadabad) was a dockyard (first Naval dock yard of the world) and not, as earlier proposed, a fresh water storage tank. We have also explained the discovery of Neolithic settlements (30-40 m water depth) in the Gulf of Khambhat - the oldest civilisation site and possibility of tsunami Dholavira (Gujarat) prompted ancient Indians to built unusually thick (18M) wall around citadel – world oldest tsunami protection measures.

Similarly, paleomonsoons studies on core samples off Karwar, west coast of India showed the clear signals of marked high rainfall around 4000 and 3500 years BP and reversal of rainfall condition since 3500 B.P. with a marked low at 2000 years BP. In addition to this, a cyclicity of approximately 77 years in concentration of drought years was deciphered which is possibly regulated by Gleissberg cycle in the radius of the sun.

A detailed foraminiferal-culture program with molecular biological approach is the need of the hour. Through such programs, existing techniques (based on circumstantial field correlations) can be validated and new techniques can be developed.

Assessment of river water and groundwater quality in the coastal part of Cauvery river, India

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Rivers and adjoining groundwater have been subjected to anthropogenic impacts. This arises the need of evaluating the water quality of not only the rivers but also its nearby groundwater. This study was carried out with an objective to assess the river water and groundwater quality in the coastal part of Cauvery river. Samples were taken for both river water and adjoining groundwater along the coastal part of the river once every four months from March 2013 to June 2016. The physio chemical parameters such as EC, pH, major cations and major anions were measured. Drinking water quality was assessed based on water quality standards of BIS and WHO. High dissolved solids were observed in groundwater exceeding the permissible limits and so most of the groundwater samples were unsuitable whereas most of river water is suitable. Parameters such as sodium adsorption ratio, permeability index, residual sodium carbonate, magnesium hazard and salinity hazard was used to assess irrigation water quality. Groundwater in most of the locations was unsuitable due to high residual sodium carbonate and the river water is suitable for irrigation purposes. The study provides basic understanding on the spatial and temporal changes and also the continuous monitoring assessment of rivers and its groundwater

Photodecomposition of triazine derivatives in aqueous medium using hydrogen peroxide and ferric perchlorate

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The photodegradations of 2,4,6-trimethoxy-1,3,5-triazine (TMT), 2,4-dioxohexahydro-1,3,5-triazine(DHT), 6-chloro N-ethyl N'-(1-methylethyl)-1,3,5-triazine, 2,4 diamine (atrazine, AT) and cyanuric acid (CA) have been investigated in aqueous medium in the presence of ferric perchlorate as photopromotor using sunlight and UV light. The hydroxyl radical ($\cdot\text{OH}$) generated from the photoreaction of the complex $\text{Fe}(\text{OH})^{2+}$, is likely to be the major active reagent. The degradation of these triazines was also studied using photolysis of H_2O_2 in which $\cdot\text{OH}$ is undoubtedly the active species. Comparison of these two methods demonstrates that photolysis in the presence of ferric perchlorate is more effective for the degradation of triazines. It is proposed that in ferric mediated degradation, photoinduced electron transfer in the $\text{Fe}(\text{III})$ -T complex formed between $\text{Fe}(\text{III})$ and triazines (T) is an additional pathway in the degradation of triazines.

Cosmogenic noble gases in Martian shergottites

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Shergottites are a type of Martian meteorites which are minerologically dominated by pyroxene and plagioclase/maskelynite. In this study we focus on shergottite-cosmic ray interaction and the production of cosmogenic noble gas nuclides ^3He , ^{21}Ne and ^{38}Ar . We have used the cosmogenic noble gases in well studied shergottites from previous measurements and noble gas data base, to understand the number of possible ejection events and the interplanetary sojourn of shergottites. Once eject from the Mars surface, shergottites are in continuous interaction with Galactic Cosmic Rays (GCR) and Solar Cosmic Rays (SCR). GCR penetrate upto meters into the meteoroid because of their energy range of ~1-10 GeV where as SCR penetrate only a few cm on the meteoroid as their flux is highest at energies below ~200MeV [3]. Usually cosmogenic nuclides measured in most of the meteorites and Lunar samples are produced due to GCR. However, in shergottites and in some rare achondrites presence of SCR have been detected in addition to GCR. For this SCR to be present, sample must be from a few cm below the surface. Usually these SCR component is absent as the meteoroids get ablated while atmospheric entry and the upper layer will be lost. The extend of ablation depends on the type of the meteorite. Garrison et al. (1995) discussed in detail the first clear detection of SCR produced Ne in the shergottite ALHA77005 [3]. Recently, in the newest shergottite fall, Tissint, the presence of SCR-Ne was detected clearly based on the cosmogenic $^{21}\text{Ne}/^{22}\text{Ne}$ ratio [5]. Though there are various reasons suggested for the presence of SCR produced noble gas in shergottites, one major reason is that shergottites had experienced different orbital parameters unlike other SNC meteorites and asteroidal meteorites. This may have resulted in the lower entry velocities of shergottites, which in turn facilitated lower absolute ablation [3]. There are some adverse effects in cosmic ray exposure age (CREA) calculation if there is SCR in addition to GCR, which will be discussed in the related paper. Cosmic ray exposure ages of most of the Martian meteorites are based on noble gases and the production rates of Eugster and Michel (1995). However, we adopt GCR based physical model by Leya and Marrik (2009), to estimate the production rates of cosmogenic nuclides. Even though exact number of impacts are not clear, Herzog and Caffee (2014) favours five distinct event to launch shergottites. These possible ejection events for shergottites are at 0.6, 1.0, 2-3.5 and 18Ma [2], which are nearly same as CREA as terrestrial ages are comparable to the uncertainties of CREA.

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Scope of Geo-informatics in describing Pattanam Archaeological site.

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Pattanam is an archeological site, located Ernakulam district, Kerala State, India. The excavation of last nine years revealed the presence of past existence an urban society, which had a trade relationship with the Arabian, west Asian and Mediterranean world. According to the testimony of various ancient literatures, both foreign and local, Periyar delta was as a hub of brisk maritime trade. Geology plays a crucial role in archaeology as it directly determines the pattern of the past human settlements as well as urbanization. To understand a geological Change that happened in Pattanam site for last two millennia, reference with other parts of Periyar river bed and floor plan as well as deltaic parts also had to take in account [1]. Use of Remote sensing and GIS, helps to understand the set of environmental parameters that might have influenced ancient settlement patterns. This may yield convincing evidences on why Pattanam area was favoured as a settlement site. The study involves a comprehensive approach by collecting information from old toposheets, Historical maps, satellite images etc. However the major conclusions about the paleo landscape are drawn from the information collection from the satellite images in the form of geomorphological map and other thematic maps.

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Substrate characters and its influence on the distribution of benthic foraminifera from the inner shelf sediments of southern part of Gulf of Mannar, SE coast of India.

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The present study aims to understand the influence of substrate characters on the distribution of benthic foraminifera collected from the inner shelf sediments of southern part of Gulf of Mannar. The sediment characters considered for the study include nature of the substrate, calcium carbonate and organic matter contents. These parameters were correlated with the foraminiferal population of the area. For the study, systematic collections of sediment samples were collected along four traverses off the coast of Therespuram, Sippiklam, Mookaiyur and Volinokkam. Samples were collected from 7 stations in each traverse and thus 28 samples were collected for each of the three seasons viz. October (pre monsoon), January (post monsoon/winter) and April (summer).

From the analysis, it is observed that the higher CaCO₃ percentage prevailed during April is one of the congenial factors for higher population during summer. The spatial distribution of CaCO₃ in the study area, is found to show a positive correlation with the population of foraminiferal fauna. The accommodative substrate for population abundance is Siltysand.

Integration of Petrophysical and Petrographic Data for Petroleum Exploration

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Petrographic data collected during thin section analysis can be invaluable for understanding the factors that control porosity and permeability distribution. Reliable prediction of porosity and permeability is important for reservoir characterization. The petrographic elements (mineralogy, texture, compaction, cements and total clays, and pore morphology) interact with each other uniquely to generate a specific porosity and permeability distribution. It is difficult to quantify accurately this interaction and its consequent effect on porosity and permeability, emphasizing the non-linear nature of the process. To capture these non-linear interactions, petrophysical and petrographical data were used to predict porosity and permeability. This study has attempted to synthesize all of the gathered data from various analyses that were performed on samples obtained from the exploration wells. Porosity and permeability measurements were carried out, and special attention was paid to detailed investigations of pore space through mercury porosimetry and computer analysis of microscopic images. The second analytical block consisted of petrographic analyses, determination of diagenesis processes and their influence on pore space, to define the processes influencing variations in pore space volume. Cementation and compaction models were verified and changes of porosity with depth were estimated. To establish the correlation between porosity and permeability values, with detritic grain distribution, granulometric analyses were also performed. The cut-off parameters of porosity and permeability in correlation analysis were defined for conventional, unconventional and mixed-type reservoirs. The results obtained enable the formation of cementation and compaction models, and to facilitate the prediction of reservoir and filtration parameters in deep-deposited layers. Mechanical compaction has caused by reduction in primary porosity with increasing overburden. Chemical diagenesis has altered the texture and composition of the sandstone and has affected porosity and permeability through cementation, dissolution, and authigenic clay precipitation. Early stages of diagenesis included pyritization, mechanical compaction, and hindrance of compaction by precipitation of quartz cement at grain contacts. The middle stages were dominated by carbonate cementation, which replaced some detritus and quartz cement and reduced primary porosity to irreducible limits. Finally, the latest stages of diagenesis included development of secondary porosity by localized dissolution of replacive and interstitial carbonate and reduction of porosity by precipitation of pore-lining and pore-filling illite and illite/smectite clays. This paper demonstrates that the application of integrated petrographic analysis and petrophysical and well- log data would produce major advances in giving preliminary recommendation for exploitation development strategic and also production optimization. Integrated petrographic data is very useful for evaluating the relationship between depositional environment, mineralogy composition, pore geometry, diagenesis, and reservoir quality, which lead to better perspective in reservoir modelling.

Paleo-environmental evidences of the Spice trade and Plant utilization from the Peat formation of Pattanam Archaeological site

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Pattanam, a small village in Ernakulam district of Kerala state, India, located on the Periyar river delta, invites the attention of scholars of various disciplines for its recent archaeological discoveries of maritime features. Large number antiquities of foreign – origin excavated from here suggests that, this area had trade relationship with the Mediterranean world, and probably was a part of ancient spice trade network, which had been mentioned in various Sangam Tamil and foreign literature accounts [1]. A single trench was excavated as part of archaeological excavation in 2015 by the Kerala Council for Historical Research, Thiruvananthapuram. Examination of peat samples, which was found as a layer of 3-5 cm in a depth of 320-325 cm yielded a diverse spectrum of botanical specimens such as thorns, seeds, fruits, floral parts, leaves, stems, barks, wood and plant resins. The presence of macrobotanical specimens resemble Black pepper(*Piper nigrum*), Cardamom(*Elettaria cardamomum*), Cloves(*Syzygium aromaticum*), Sesame(*Sesamum indicum*), Chillies(*Capsicum* sps.) etc., pointing towards the ancient spice trading activity. The paleo-environment of Pattanam area was represented by the plant specimens such as *Cocos nucifera*, *Bombax* sps., *Erythrena* sps., *Zanthoxylon* sps., *Phyllanthus emblica* etc. Diversity of discovered ethnographically important botanical specimens suggests the relationship between plants, trade activities and paleo-environment of this area in the ancient times.

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A geochemical-statistical approach for the natural background levels of selected groundwater quality parameters in parts of Tanjavur district, Tamil Nadu, India.

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Assessment of groundwater quality is an integral part of water resources development and management, in any of the groundwater dependent water supply systems around the world. Estimating the naturally occurring water quality is the preliminary step in detecting the anthropogenic influences. In this study, we have tried to ground a natural back ground level of selected parameters in parts of Tanjore district using a geochemical and statistical methods. The threshold values of water quality parameters were obtained from cumulative probability Plots. Results show that the groundwater is affected by both natural and anthropogenic influences. The methods used in this study can be extended to other part of the world.

Aspects of Sedimentary Petrology that impact on Petroleum Exploration

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Sedimentary petrology is concerned with the origin of sediment and sedimentary rocks. Clastic sedimentary rocks are rocks composed predominantly of broken pieces or clasts of older weathered and eroded rocks. Clastic sediments or sedimentary rocks are classified based on grain size, clast and cementing material (matrix) composition, and texture. The classification factors are often useful in determining a sample's environment of deposition. The composition of siliciclastic sedimentary rocks includes the chemical and mineralogical components of the framework as well as the cementing material that make up these rocks. Within sedimentary rocks, sandstones are very-fine to very-coarse grained rocks composed of rounded or angular fragments of sand size, that often but not always have cement uniting them together. These sand size particles are often quartz minerals but there are a few common categories and a wide variety of classification schemes that are given are used to classify sandstones based on composition.

Porosity and permeability are the most important attributes of reservoir quality. They determine the amount of oil and gas a rock can contain and the rate at which that oil and gas can be produced. The reservoirs initially have intergranular (primary) pores that are main space for oil and gas accumulation. When the reservoirs are deposited, their primary porosity is frequently destroyed or substantially reduced during burial compaction and cementation. Sandstone framework components constitute an extremely important pre-burial control on reservoir quality potential for petroleum exploration. Composition and abundance of principal framework grains have a great impact on physical/ chemical diagenetic processes controlling porosity and permeability reduction, preservation and enhancement with burial. Sandstone diagenesis involves porosity loss by mechanical and chemical compaction and various pore filling cementation.

Traditionally, porosity and permeability were determined through the study of drilling samples, analysis of cores obtained from the wellbore and plugs from formation side wall. Reservoir quality of sandstone can be described through thin section, scanning electron microscope and X-ray diffraction techniques, additionally with mercury injection capillary pressure analysis, fluid inclusion and isotopic analysis. These analyses were used to describe diagenetic alterations, characterizing and quantifying more accurately the different mineralogical phases and their influence on porosity and permeability of sandstones. These diagenetic alterations include compaction, quartz overgrowths, authigenic clay minerals, carbonate cement, authigenic feldspar, authigenic pyrite and iron oxide cement. Thus, the better understanding of diagenetic modifications through sedimentary petrology has been of great importance in the exploration and exploitation of hydrocarbons.

Spectral and chemical characterization of Kadavur anorthosite complex

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The Kadavur anorthosite complex (KAC) lies in the northern part of the Madurai block. Kadavur anorthosite complex is a dome shaped complex situated at 10° 35' N, 78° 12' E in Tamil Nadu, India. The KAC occur as funnel shaped dome. KAC is mainly associated with anorthosite, quartzite, hornblende and biotite gneiss. The Kadavur anorthosite complex was crystallized at 829 ± 14 Ma (Teale et.al 2011). The characterizing the Kadavur anorthosite complex spectrally and chemically will help us in making the spectral chemical relationships. Thus the spectra can be used to get the quantitative results of anorthosite. The anorthosite is a light coloured plagioclase rich rock. Mafic cumulates are less abundant in Kadavur anorthosites. The Kadavur anorthosites are devoid of pyroxenes. Amphiboles are the main mafic mineral component. The reflectance spectroscopy of the KAC showed characteristic broad peak of absorption at 1250nm, which is due to the electronic transition of trace amount of Fe^{2+} present in the plagioclase structure. The absorption strength of the peak increased with increase in FeO content. These peaks also got shifted from 1250nm-1300nm due to variation in An content of the anorthosite. The Electron Microprobe analysis of Kadavur anorthosites gave An value ranging from An45 - An70. The mafic minerals show low Mg# (40-70). Laser Raman spectroscopy of the samples were also done to characterize the Kadavur anorthosite.

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Temporal variation of inner shelf environments and its effect on the distribution of Ostracoda from the southern part of Gulf of Mannar, Southeast coast of India

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To understand the impact of temporal variation of inner shelf environments on the distribution of ostracods, a systematic collection of sediment and bottom water samples were made at 7 stations in each of the traverses from off the coast of Therespuram Sippikulam, Mookaiyur and Volinokkam for three seasons representing Pre monsoon, Post monsoon/winter and summer.

54 ostracodal species were identified belonging to 36 genera have been identified. The various sediment and bottom water parameters have been evaluated in the study area. Temporal variation of temperature, salinity and dissolved oxygen content of the bottom water shows a positive correlation with the distribution of ostracoda. Temporally, during April (summer), CaCO₃ content is found to be higher and encountered with higher population of ostracoda. The silty sand types of substrate is more during summer and congenial for higher population

A low cost domestic defluoridation filter – a Case study from Palghat, Kerala, India

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High fluoride is reported from both phreatic and deeper aquifers in the eastern part of Palghat district^{1,2}. [1] [2]. Chittur block represents a mid land region with an area of 261 sq km with six panchayaths. A KSCSTE, Govt of Kerala funded project study reveals that both phreatic and deeper aquifers of the area have high fluoride groundwaters. In dug wells F⁻ concentration ranges from 0.2 to 6.3 ppm with the highest concentration at Kopanur²[2]. In the deeper aquifers the concentration ranges from 0.3 to 3.5 ppm². Nellipally, Kozhinjampara and Eruthenpathy are the worst affected panchayaths. 50% of the area in each of these panchayaths is under the threat of fluoride contamination. Dental fluorosis is observed in the area and children in the age group 8 to 18 are the worst affected. Dental fluorosis is mostly noticed in Kopanur, Eruthenpathy, RVP Puthr, Kozhinjampara, Kozhipara, Vannamada, Ozhalapathy and Chinnamoolathara areas of Chittur block. Groundwater is the main drinking water source of the area. Since alternative sources of water are limited, defluoridation may offer a practical solution to the problem. Several methods of excess fluoride removal from portable water are used in our country. But this area yet to practice any defluoridation technique. In the present study, a simple domestic defluoridation filter is developed. Palghat is known as land of palm trees. These plants are spatially well distributed in this region. Barks /parts of the palm tree are used to make charcoals and have been used as adsorbing media. Charcoal is prepared from the dry stems/*panampatta* or barks of the palm tree. Charcoal was prepared by charring the dried plant materials at about 100-200° C in a muffle furnace, at which all of the material was completely carbonized. The carbonized material was cooled and then grounded in a laboratory blender and made into fine powder. The finely divided powder of palm charcoal is then sorted in a desiccator and used for biosorption studies. The materials used for making the bio-filter are : 1. Charcoal, 2. Water sample and 3. River sand. This filter is a cost effective remedial measure which can be adopted at community level and individual households. The materials are very much available in the area. Moreover, cost of defluoridation is almost nil with no negative impacts.

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Supra-Subduction Zone Ophiolite: A key to understand the evolution of oceanic lithosphere

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Ophiolite may form in different tectonic settings. However, a majority of the ophiolites have been conceded in the geologic record for over three decades, been formed above supra-subduction zone (SSZ ophiolite). The supra-subduction zone ophiolite forms in an incipient forearc by extension and magmatism due to sinking of subducting slab and hinge roll-back at the initiation of subduction. Majority of the SSZ ophiolite can be recognised by their continuous magmatic chemostratigraphic evolution. Usually the chemical composition of the rocks vary from mid ocean ridge basalt (MORB) to arc like lavas (volcanic arc basalts or VAB $\pm$ boninites or bon) where SiO₂ composition ranges from 45 wt% to 80 wt%. The rocks show increasing depletion of HFSE (Zr, Hf, Nb etc) and enrichment of LILE (Rb, Ba etc), respectively. During initiation of the subduction and forearc spreading MORB like magmas generate due to decompression melting of mantle. As the subduction proceeds, continued melting results in depleted mantle residue (hurlburgite), progressively metasomatised due to continuous input of fluid from subducting slab and sediments. Melting of metasomatised mantle residue gives rise to IAB and boninite like lavas, consequently. Therefore, more evolved boninite like lavas in ophiolite crustal sequence represent a matured subduction system. This review represents the chemostratigraphic evolution of the Tethyan ophiolites. According to the chemostratigraphic evolution, Cyprus ophiolite represents a matured subduction system whereas Andaman ophiolite represents an early to intermediate stage of subduction. Therefore, the subduction of oceanic lithosphere initiated at Cenomanian (93-100 Ma) along Tethys from Cyprus through Oman to the Andaman Islands represents a matured to intermediate and/or early stage of subduction system and sequential closure of the ocean basin.

Indian monsoon rainfall variability: evidence from the late Quaternary sediments of the Andaman Sea.

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Concerns over future global change have increased interest in understanding past changes in climate and their effects on the environment, ecosystem and human society. Climate scientists are working on geological records especially marine sediments to better understand the past climate variations. Monsoon is a seasonal reversing wind accompanied by corresponding changes in precipitation and its failure in the past has led to severe droughts, famine, affecting economy and food security of South Asian countries. Since the Indian economy is heavily dependent on summer monsoon rains, understanding its past and present variability is of immense importance in making any attempt in predicting future monsoon variability. In this perspective, we studied the variation of monsoon in the geological past by using fossil records (foraminifera and pteropods and their stable isotopic compositions) preserved in the sediments of Andaman Sea. Andaman Sea is a marginal sea and part of a core convective region of Indian summer monsoon. The sediments of Andaman Sea are mainly transported and deposited by Irrawaddy River. It is estimated that Irrawaddy River drains ~428 km³ of fresh-water annually from the Irrawaddy catchment region to the Andaman Sea [1]. It host a unique system of inter-related oceanographic, biological and sedimentary processes induced by the seasonally reversing monsoon winds and yield a potential paleoclimate record and one of the best place for studying Indian Ocean monsoon variability and resultant erosional history of Himalayan-Burman ranges [2].

Our study shows that there are several times in the past, monsoon were weak/strong and these fluctuations are inevitable part of the climate system. The proxy profiles show glacial-Holocene millennial scale monsoonal climate changes and associated productivity fluctuations. Water column stratification and productivity collapse are seen associated with summer monsoon evolution from last glacial to Holocene. Intensification of summer monsoon started at 14000 years before present followed by slight weakening during ~12500 years BP and regained the strength and was highest during early to mid Holocene. This enhanced summer monsoon during early to mid-Holocene resulted in huge fresh water runoff that slowly muted upwelling and productivity by intense stratification. Summer monsoon was weaker during several periods like Heinrich Event 1, late glacial (19-16 ka), last glacial maximum (23-19 ka), 38-34 ka and 46-41 ka. A progressive gradual decline in the total planktonic foraminifera abundances from mid Holocene to present suggests a gradual weakening of the summer monsoon [3]. This late Holocene weakening trend is a great concern to climate scientists and need to establish with further evidences. Our record shows that Indian monsoon variability in the past has been controlled by solar insolation as well as the North Atlantic climate changes through atmospheric teleconnection.

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Hydro chemical characteristics of Muriyad wetlands, Kerala- An Appraisal

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The Kole lands of Thrissur district represent a unique fragile ecosystem of central Kerala. Some parts of this wetland is located below mean sea level and is actually the flood basin of the rivers, namely the Karuvannur, Keecheri of the Thrissur district. The Muriyad wetlands which form part of the Kole wetlands is one among the eight fresh water wetlands of Kerala. The area drains to Arabian Sea through Chettuva estuary, which also serve as the part of saline water ingress from the sea.

An assessment of physiochemical quality of water in dug wells of Muriyad wetland was undertaken during the post monsoon, pre monsoon and monsoon periods extending from December 2013 to August 2014. A network of 15 sampling locations was identified. Samples were analyzed for pH, conductivity, TDS, turbidity, DO, chloride, salinity, alkalinity, hardness, Ca, Mg, Na, K, sulphates, phosphates, nitrates etc. During the pre-monsoon period, the value of pH lowers down and turns acidic in most of the wells. Turbidity of water ranges from 1.45 to 34.7 NTU. Conductivity ranges from 56 to 524 μ s. The nitrate content of well water exceeds the drinking water standard. The value of Potassium goes up to 433.4 ppm. The salinity reaches a maximum value of 278.4 ppm. However during monsoon period the quality of water improves and attains the desirable limit of drinking water standards. In the post monsoon period the salinity and nitrate content of well water exceeds the limit of drinking water standards. Characterization of the water samples were carried out using Piper diagram and Sodium Absorption Ratio diagram.

In this paper, an attempt has been made to assess the quality of water, its spatial variation and the impact of anthropogenic activities on the quality of water. This may help to stream line the management strategies to conserve the precious water.

Climate and saprolite characteristics: key factors in landslide disasters in Western Ghats India.

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Mineralogy, chemistry and material properties of saprolites formed by insitu weathering of hard crystalline rocks play a crucial role in the development of landscape. Saprolite from twelve weathered hill slope profiles which failed during monsoon period were collected and determined the mineralogy, chemistry by means of X-ray diffraction (XRD) and X-ray Fluorescence (XRF) respectively. The material properties were also determined in strength of materials laboratory. It is found that these rocks have low cohesion and angle of internal friction. The percentage of clay minerals is also high. The paper examines the correlation existing between the mineralogy, chemistry and material properties. It is found that cohesion and friction angle decrease with increase in percentage of clay minerals. However these properties increase with increase in the content of quartz and feldspar. Angle of internal friction is negatively correlated with iron oxide content which is attributed to increase in degree of weathering. Heterogeneities with respect to different parameters often control the mechanism and location of the slope failure. The factor of safety of slopes depends on the weakest link in the weathered rock profile, the saprolite. It is observed that relict discontinuities create pathways for rain water and the percolating water is accumulated in the relatively weak saprolite zones which are under lied by impervious hard crystal rock. Consequently pore pressure builds up, shear strength decreases and arcuate shear failure occurs during periods of continuous rainfall. A better understanding of the interactions among mechanical, chemical and engineering properties should enable the characterization of hill slopes. These properties in turn modify the mechanical/hydraulic behavior and hence control the stability of saprolitic slopes. There by providing a more rational basis for investigation and design practice in a saprolite profile.

Assessment of Tsunami Hazard for Cuddalore Coast, South East India

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The Indian Ocean Tsunami (IOT) generated by the earthquake along the Andaman - Sumatra Trench with the magnitude of M_w 9.1 on 26th December 2004 killed about 2,30,000 lives. This earthquake occurred 160 km off the northwest of Sumatra close to the Andaman – Sundah trench where the Indian plate is subducting beneath the Burma plate. The tsunami devastated the southeast coast of India and the coastal community in Tamil Nadu were worst affected with more than 8,000 fatalities. The fatalities are highest in the districts of Nagapattinam where 6065 people died, followed by Kanyakumari with 799 deaths and Cuddalore where 617 died. Though the reoccurrence interval of a mega tsunami may be few centuries, the industrial developmental taking place in the coastal zone of Cuddalore District necessitates assessment of tsunami hazard in the district. The tsunami hazard assessment was carried out using hypothetical scenarios generated by numerical modeling with TUNAMI – N2 developed by Imamura which is also used by Indian National Centre for Coastal Information Services (INCOIS) the nodal agency for Indian Ocean Tsunami Early Warning System. The model was first validated for its predictability. The model was first run with the earthquake parameters of IOT – 2004 and comparing the results with the tsunami travel time, water level recorded by Jason – 1 satellite 2 hours after the origin of the IOT – 2004 in Bay of Bengal and inundation data collected in Cuddalore coast after the tsunami. Five hypothetical sources (Block 1 to Block 5) taken based on the tectonic framework of the trench were considered with magnitudes M_w 8.0, 8.5 and 9.0.

The results show that the offshore bathymetry influences the amplitude of tsunami as it reaches the nearshore. The tsunami flowing through submarine canyon reaches the coast with reduced amplitude. The run-up increase when the tsunami encounters the dune barriers but when it propagates through low lying wetlands, the wave height is reduced. The tsunami inundation is more in the areas where rivers confluence and the adjoining low lying marginal marine environment. Inundation is less in the areas protected by dune ridges but during a massive tsunami event if it overtops the dune can inundate far inland. Thus the run-up and inundation due to tsunami are related to the geomorphology of the coastal zone.

It was found that inundation due to the tsunami originating in Block 3 located near Kachal Island produced the most destructive tsunami due to M_w 9.0 earthquake as the tsunami is directed towards Tamil Nadu. The areas where maximum inundation of upto 5 km was noticed are in Kayalpattu though the coast is protected by dunes. The longer inundation is also encountered in the villages located in the floodplain of Vellar River where the inundation is more than 4 km.

Human - elephant conflict detection and mapping using Geoinformatics

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Human elephant Conflict is a burning issue that is needed to be discussed upon which is more prevalent in attirappilly- malakkapara region. It is one of the most serious issue that affect the farmers of that region and as the years pass by, the conflict graph is getting higher. The other disturbing fact is that there is no effective conflict control measure to escape from serious issue. It not only leads to the economic loss but also creates mental agony and worries. The elephant attacks are getting more in number, such that earlier prediction may not be possible as well. The scary situations are created by the elephant attack, people are afraid of these attacks at any time, particularly in the athirappilly- malakkappara region. The agricultural loss, economic loss and mental stress and mostly even threaten to the life and property are the major negative impacts of these elephant attacks. Even though the government authorities are provide the compensation but still are limitations, and these funds may not provide The farmers to meet their losses. In the study seven maps are created by using geographic information system (GIS) they are drainage map, drainage buffer map, human elephant conflict history map, human elephant conflict prone area maps are those ones which are created by the GIS. Remote sensing data is used for the preparation of landuse of the area. Hence this study is more essential and required to check the elephant conflict prone areas and should lie a step to think to formulate new measures and management systems to prevent the human elephant conflict, for the humans to live on as well as to provide then protection and care. The same time, the elephant population has to be protected, where there should be a mutual balance and harmony between the man and nature.

Drought hazard mapping in Attapadi using GIS and Remote sensing techniques

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Modern technology has made substantial contribution in the identification of drought vulnerable area. Drought is one of the climatic, natural disasters, having an impact on both the economy and the society, with its long-standing problems. Drought by nature is a result of inter-related parameters. The study is based on the concept that the severity of the drought is a function of rainfall, hydrological and physical aspects of the landscape, leading to meteorological, hydrological and physical drought. Drought vulnerability is a concept which shows the likelihood of damages from hazard in a particular place by focusing on the system status prior to the disaster. Drought vulnerability has been viewed as a potential for losses in the region due to water deficiency at the time of drought. In this study the vulnerability of drought in Attapadi province in Palakkad district is investigated by providing vulnerability maps which demonstrates spatial characteristics of drought vulnerability. In the present study a Geographic Information Systems (GIS) and remote sensing -based tool for drought vulnerability assessment at a micro level has been developed. T Drought is one of the climatic, natural disasters, having an impact on both the economy and the society, with its long-standing problems. Drought by nature is a result of inter-related parameters. The study is based on the concept that the severity of the drought is a function of rainfall, hydrological and physical aspects of the landscape, leading to meteorological, hydrological and physical drought. In the present study a Geographic Information Systems (GIS) and remote sensing -based tool for drought vulnerability assessment at a micro level has been developed. The output of the study shows different zones of drought vulnerability ranging from low, medium, high and very high. The result of the study was used for the officers and public for the better management of water resources and biodiversity conservation strategies.

Petrography and geochemistry of calc-silicates from the Western Madurai Block, southern India

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Calc-silicates are high grade metamorphic rocks which are mainly composed an assemblage of epidote, zoisite, vesuvianite, diopside - hedenbergite, Ca-garnet (grossular - andradite), wollastonite, anorthite, scapolite and Ca-amphibole. These rocks are geochemically distinct from the associated metasedimentary rocks and hence ideal rock units for understanding the mobility of elements and metasomatism in the lower crust. The mineral assemblages of calc-silicate rocks are relatively sensitive to the water content in metamorphic fluids and can be used as an important indicator for the compositional changes in fluid during metamorphic evolution. The calc-silicates were collected from two locations near Ernakulam, Kerala in the Western Madurai block. These were found as thin bands, enclaves or boudings within the country rocks. The major rock type of the study area includes charnockite, hornblende biotite gneisses and quartzo - feldspathic gneisses. The country rocks are highly deformed and parallel foliations have a general trend towards northwest directions. Megascopically the rock samples contain 85-90 % calcite and scapolite, wollastonite, clinopyroxene, quartz and graphite as accessory phases. The calcite grains are large and rhombohedral with graphite flakes in triple point contacts. The graphite flakes are also present in associated charnockites in the location. The geochemical analysis of calc - silicate samples shows SiO₂ ranging between 40.31 - 41.22 wt. % and CaO 50.59 - 55.18 wt. %. All analyzed calc-silicates contain minor elements K, Na, Mn, Ti, and P in oxide amounts less than 4 wt. %. None of the samples has a negative Eu anomaly and the uniformity in REE abundance patterns is striking, in comparison with the variations in composition of the major, LILE and ferromagnesian trace elements. The average sedimentary REE pattern and is very similar to other post Archean sedimentary REE patterns from elsewhere in the world. Geochemical characteristics possess remarkable view of the laterally discontinuous nature of the sedimentary horizons.

P–T–t evolution of the Mahakoshal supracrustal belt, Central India: Evidences from a corridor study

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The Mahakoshal Belt (MB) is located along the northern margin of the Central Indian Tectonic Zone (CITZ) and is regarded as the oldest supracrustal belt within the collision zone. The belt consists of phyllites, micaceous quartzites, banded iron-formations, andalusite schists and amphibolites [1]. The present study aims at demonstrating the P–T–t evolution of the andalusite schists within the eastern corridor of the MB. Based on integrated structural and microtextural studies, we observed three generations of foliations, S_1 , S_2 and S_3 developed during D_1 , D_2 and D_3 deformation events respectively. Inclusion trails of biotite and phengitic mica within the andalusite porphyroblasts define the early S_1 foliation. The pervasive S_2 foliation warps around the andalusite porphyroblast, whereas the S_3 develops axial planar to the crenulated S_2 . The discordant relation between the internal foliation of the andalusite and the warping external matrix foliation indicates an intertectonic growth of the porphyroblast between the D_2 and D_3 deformation events. The mineral paragenesis combined with pseudosection modeling suggests three stages of metamorphism, where the peak assemblage (M_1) of phengite + biotite + quartz $\pm$ muscovite $\pm$ chlorite was stabilized at ~ 8 kbar, 520°C . The near isothermal decompression of MB schists at ~ 3 kbar led to the stabilization of andalusite bearing (M_2) assemblage. The post- D_3 calcium-rich fluid activity has resulted in the replacement of andalusite porphyroblasts with margarite bearing pseudomorphs (M_3) at ~ 2 kbar. In MB schists/phyllites, the relative timing of metamorphism is constrained using the electron microprobe (EMP) chemical dating of monazites [2]. The U–Th–total Pb monazite ages limits the peak metamorphism (M_1) between 1900 and 1800 Ma. Similarly, the late Paleoproterozoic and early Mesoproterozoic ages (1700–1600 Ma; 1600–1500 Ma) from patchy monazites represents the low-P metamorphic events (M_2 and M_3) in schists respectively. Thus, we suggest a clockwise P–T path for the MB at near isothermal decompression conditions.

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Significance of corona textures in ultrahigh temperature assemblages: A petrological approach towards continental correlation

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The region of Enderby Land in East Antarctica consists of regionally metamorphosed amphibolite to granulite facies rocks. This can be divided into several sub-regions such as Napier complex (Archean), Rayner complex (Proterozoic) Lützow Holm complex (late Paleozoic) and Yamato- Belgica complex (early Paleozoic). A petrological and textural study is made on samples from Akarui Point, Lützow Holm complex where we observed ultrahigh temperature metamorphic mineral assemblages. These assemblages are compared with those samples from Sengal, Tamil Nadu which is in the Palghat Cauvery shear zone which also hosts high grade rocks with UHT assemblages^{1,2,3}. [1] [2] [3]. Minerals are arranged in a multiple corona fashion in an amphibole matrix. The texture has corundum in the core and it is surrounded by rims of spinel and sapphirine around it. Sapphirine is indicative of ultrahigh temperature metamorphism⁴. [4] In samples from Akarui Point⁵, [5] Antarctica, an outermost rim between sapphirine and the amphibole matrix is present which is composed of anorthite whereas in PCSZ, cordierite rim is seen instead of plagioclase. This variation is significant when considering the difference in amphibole composition in both the samples. The reaction between corundum with two types of amphiboles are studied and differences in resulting rims are concluded. The observations are further studied based on continental correlation aspects. A new implication is made matching Palghat Cauvery shear zone with Akarui point as counterparts of the giant jigsaw puzzle of plate tectonics.

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Effect of Climate Change on Antarctic ice sheets and Himalayan Glaciers

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Cryosphere is that part of the Earth's surface, where water is in solid form – like snow, glaciers, ice caps, ice sheets, sea ice, and frozen ground (permafrost). The cryosphere affects the global climate due to the extremely high reflectance (albedo) of the white icy surfaces. It is also vulnerable to the ongoing global warming and responds to global and regional climate system on various timescales. The effect of global warming is most perceptible and amplified in the polar regions – the Antarctic, Arctic as well as the Himalaya (the Third Pole). Polar regions have a very vital role in the Earth system processes and the climate system. It is now evident that the global warming and associated climate change is affecting the health of the glaciers in Himalaya and the ice shelves and ice sheets of Antarctica.

Antarctica comprises the area on Earth south of 60°S, and makes up about 10% of the land surface of the Earth with the combined area of the ice sheets and ice shelves being about 14×10^6 km². Ninety eight percent of Antarctica is covered by thick ice sheets that contains about 90% of the world's 'permanent' ice and 70% of its fresh water. Our knowledge of the role of Antarctic cryospheric system within the global system and the spatial and temporal complexity of Antarctic climate is still poor, which is largely due to the limited and the short period of observational and instrumental data on Antarctic climatic variables, collected over the last few decades. Understanding the Antarctic climate variability on millennial, centennial to decadal level is crucial to our knowledge on the role and response of Antarctic ice sheets to the global climate variability. One of the most widely used and best available method to understand these complexities is to study the ice cores obtained from the Antarctica that offer continuous, highly resolved long term records of not only temperature and precipitation, but also on atmospheric composition and transport. The Indian ice core studies have made significant contributions to the understanding of Antarctic climate variability and the various factors involved.

The unique geographic region centred around the Himalayas and Tibetan Plateau is widely known as the Third Pole, because its ice fields contain the largest reserve of fresh water outside the polar regions. Understanding the behaviour of these glaciers and their contribution to the sustainable supply of water for mankind and agriculture is one of the grand challenges of Indian scientific community. As part of the Indian government's initiatives to understand and quantify the glaciers, National Centre for Antarctic and Ocean Research (NCAOR) under the Ministry of Earth Sciences, had initiated an integrated project to quantify the glaciers in the upper Indus basin (Chenab basin) in Himachal Pradesh, their climatic response and their contribution to river discharge. An integrated study using glaciological, geodetic, glacio-hydrological methods will quantify the glacier stability in this region and will also quantify the contribution from glacial melt water to the river discharge in Indus basin.

Response of the benthic foraminiferal community records and geochemical approaches at Cascadia Margin

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We investigated benthic foraminifera and Total Organic Carbon from sediment cores collected through IODP Expedition 311 at Hole 1325B Cascadia Margin North-East Pacific Ocean. In addition to these results, $\delta^{15}\text{N}$ [1] and Marine Isotopic [2] records are also compared for better interpretation for paleoceanography. Benthic foraminifera represented by ~52 species belonging to 31 genera are recognized in samples of late Pleistocene epoch (~1200 kyr). In this present study we have mainly focused on the ~200 kyr to recent where the faunas are highly populated. *Bolivina spathulata*, *Bulimina striata*, *Gavelinopsis lobatulus*, *Pleurostomella alternans* and *Uvigerina peregrina* are species that are notified to be dominant especially during 50-10 kyr. This faunal enrichment is influenced by the California Current System (CCS) which bifurcated from the North Pacific Current to south. The incursion of warm and saline water from North Atlantic ascribed the relative changes of upwelling and circulation pattern of the CCS. The nutrient utilization rate $\delta^{15}\text{N}$ (7.5 %) accounts to be high during ~15 kyr is also considered as sustaining evidence. The warm interglacial (MIS 1 and MIS 3) and cold glacial (MIS 2) isotopic stages takes place within the mentioned span in which the sedimentation records (~38.3 cm/kyr) are characterized by the marine organic matter and terrigenous origin as responsible factors respectively. The positive correlation of *Uvigerina proboscidea* with organic carbon flux region which have greater abundance induces the declining oxygen concentration. It is clearly noticeable that this study gives promise to use the Cascadia Margin foraminiferal distribution pattern as a paleoenvironmental tool for Quaternary Marine Research.

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New advancements in slope stability monitoring using remote sensing

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Detection and monitoring of slope stability are necessary for better hazard assessment and infrastructure planning that can be particularly challenging for large geographical areas [1]. The advances in remote sensing viz., Interferometric Synthetic Aperture Radar (InSAR) and photogrammetric techniques, have overcome this by substituting the traditional geotechnical in situ monitoring that requires invasive instrumentation installation [2,3]. The remote sensing techniques can be used real-time to proactively monitor slopes through its high spatial- and temporal-resolution data. Space-borne radar sensing could potentially be a very powerful monitoring tool, able to observe very large areas as well as remote sites without ground installations and personnel involved [4]. However, lack of coherence due to vegetation and other factors between two passages of the satellite sensor can affect the final output [5,6]. The studies of SAR are based on multiple interferograms derived from a large set of SAR images to distinguish temporally correlated motion phase from temporally random atmospheric phase [7]. The advancements in the spatial and temporal resolution of satellite-based remote sensing using Synthetic Aperture Radar (SAR) thus provide a new paradigm in landslide studies. Also, manned and unmanned aerial platforms offer an opportunity to acquire optical images as the user requires. These optical images can be processed using digital photogrammetry software to derive point clouds to make precise 3D measurements. These remote sensing techniques provide an excellent opportunity to monitor and study such hazards especially in complex geologic conditions.

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STUDIES ON PHYSICO-CHEMICAL PARAMETERS OF GROUND WATER SAMPLES COLLECTED FROM DIFFERENT AREAS THRISSUR DISTRICT, KERALA STATE, INDIA

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Water plays an important role in maintaining plant and animal life. Lack of good quality drinking water and water for sanitation cause health problems. Water quality characteristic arise from a group of physical, chemical and biological factors. The dynamic balance of the aquatic system can be destroyed by human activities resulting in water pollution. Well water traditionally considered as a safe resource of water for consumption without treatment and extensively used for individual water supply in rural and many urban areas. In this paper a preliminary analysis is done to explore the water quality at selected wells in order to correlate the effect of pollution on water quality at these locations. The analysis of groundwater quality of important town areas of Thrissur district was carried out during the pre-monsoon period. The physicochemical and biological parameters such as temperature, turbidity, electrical conductivity, total dissolved solid, pH, alkalinity, chloride, salinity, total hardness, calcium, magnesium, iron, phosphate, sulphate, dissolved oxygen, biological oxygen demand, chemical oxygen demand, total coliform count and *E. coli* were determined. Most of the physicochemical parameters were observed above the desirable limit but below the permissible limit of drinking water standards of World Health Organization (WHO). Total coliform bacteria count values of different samples are within the permissible limit. The studies reveal that samples from Thrissur town (T), Kodungaloor (K) and Chalakudy (C) shows the presence of *E.coli* bacteria. All other samples were negative for *E.coli* bacteria. Dumping of wastes near road sides, flood due to heavy rains, improper waste management in hospitals, markets, flats etc increases the pollution of ground water. The results were compared with WHO guidelines, 2006 and Bureau of Indian Standards (IS: 10500, 1991) desirable limits for drinking water.