

2nd INTERNATIONAL CONFERENCE ON
**GEOLOGY: EMERGING METHODS AND
APPLICATIONS - GEM 2019**



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Organised by

**DEPARTMENT OF GEOLOGY AND
ENVIRONMENTAL SCIENCE
CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA
THRISSUR, KERALA**

ABSTRACTS AND PROGRAMME

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MESSAGE

I am delighted to know that the Department of Geology and Environmental Science, Christ College Autonomous, Thrissur, Kerala is organizing a conference on Geology: Emerging Methods and Applications (GEM-2019). This is the second time Ministry of Earth Sciences (MoES) is supporting this initiative, and with the extent of response this event has received from various corners shows its merit.

Apart from establishing scientific research, observation and forecast facility, it is also the mandate of the ministry to spread awareness and capacity building in various domains of geoscience. The country at present is reeling from a number of natural disasters in the form of floods, cyclones, landslides, earthquakes etc. The vulnerability to natural disasters has increased to a higher level than ever before, more so due to the changes in climate, weather pattern, increase in population, unscientific construction practices, etc. MoES encourages scientific research and support initiatives towards this direction to ensure safety and security of people and to improve the understanding of these phenomena in order to establish scientific decision-support system and accurate prediction capabilities.

I hope the conference provides an opportunity for the students, academicians and researchers to gain more knowledge on recent developments and bring this understanding to the society to cater to its needs. I convey my best wishes for the success of this conference.


(M. Rajeevan)

Message from the Organizing Secretary

On behalf of the organizing committee, I would like to welcome you all to the 2nd edition of our conference on Geology: Emerging Methods and Applications (GEM-2019) which is being held at Thrissur, Kerala. The overwhelming response that we have received from various Institutions for our “call-for-papers” indicates the relevance, dynamism and contemporary nature of GEM- 2019. It is heartening to get great support and consideration from reputed scientists.

In recent years various disciplines of Earth Science has emerged as an independent and interdisciplinary science owing to advancements in methodological and analytical capacities. These have provided a renewed interest in fathoming various fields of Geology and applying those findings for societal use. Brining this development and knowledge to the grass-root level is essential for moulding the geoscientists of the future. Lack of disaster preparedness and management strategies has caused us huge revenue loss and causalities recently due to earthquakes, cyclones (e.g., Hudhud, Ockhi) and floods (e.g., Kerala, Assam and Nagaland). In the light of such recent events, the conference has invited discussions on natural hazard management plans and to envisage future policies for mitigation, by emphasizing the importance of integrated natural resource management.

The conference tries to disseminate geological research and methods being carried out in the main stream focused in Central research Institutes and Universities across India and internationally to the students and early career researchers of State Universities and Colleges. It is also aimed to create an inter-university Collaborative Academic Network among teachers and researchers of Geology. I would like to thank you all for attending the conference and sharing your expertise with young minds. We are looking forward to a fruitful gathering of great scientists and eager minds, sharing new and exciting research in wide areas of Geoscience. I take this opportunity to thank the entire team who has worked tirelessly behind the scenes towards making this event possible.



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INVITED TALKS

SUSTAINABLE DEVELOPMENT GOALS AND GEOSCIENCES OF THE FUTURE

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Sustainable Development Goals (SDGs) for global wellbeing are both, noble in their aims and daunting in their dimensions. Successful delivery of this effort can only be achieved by pragmatic mix of policies, political will, public participation, and above all informed, evidence-based and technologically feasible scientific inputs. United Nation's International Year of Planet Earth provided a window into the societal challenges the geosciences would face. Key issues of Energy, Water, Food, Health and Shelter (EWFHS) would require construction of new and dynamic paradigms that involve interdisciplinary and holistic approaches.

From the point of view of Geosciences, paleo-records make it clear that the effects of Global forcing get substantially modulated by local factors. These imply spatially varied responses of geomorphic systems to the same forcing and with varied thresholds. In respect of landscape modeling and land use dynamics, an understanding of regional contexts for each of the issues will be the key. In fact, *Think Global and Act Local* will be the key paradigm for the success of the entire SDG firmament.

Thus for example ensuring food security will require, a) a thorough understanding of hydrological cycle on various spatial and temporal scales; b) understanding of rainfall amount and distribution patterns through a season, c) soil formation processes and the role of biology in their formation and the like Similarly planning for the floods -normal, urban and nuisance, would need a better quantification of respective geomorphic spaces needed by them. Other important areas of research will be towards elucidating the role of biology in geology. The use of Solar energy may be limited by the supply of pure silica and the environmental impacts of new materials still need elucidation. I shall elucidate some of these aspects that will imply a total reorientation of geosciences the way it is done. We will need to provide quantitative-spatial and temporal data on sediment fluxes determine time scales of each of geo-proxies and use them in a conjunctive mode to tease more information on the processes.

For Geoscientists, this will be a time to unlearn and relearn.

CONTRIBUTION OF REMOTE SENSING AND GIS TECHNIQUE IN EARTH AND PLANETARY SCIENCE STUDIES

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Remote sensing was emerged as one of the breakthrough technologies in resource inventory, particularly in geological applications like rock type delineation, mineral exploration, structural mapping, landform studies, groundwater exploration and management, disaster mapping etc., The technology primarily evolved as aerial photography and interpretation during and after 2nd world war time. The technology was moved into next level during 1970s when USA had launched series of Landsat satellites. The spatial resolution of satellite image was 80m (MSS) during that time and now it has improved tremendously to less than 1m resolution like Indian Cartosat2 image. In parallel, the concept of GIS (Geographic information systems) has emerged 1960s and it was proliferated as an important geospatial tool during 1980s. The technology was largely used for spatial data storing, integration and analysis. Now it becomes an integral part in decision making, planning and dissemination of information through internet. In this presentation, the application of remote sensing technology at various stages of earth resource mapping is discussed. During 1988-1990, ISRO has carried out a nationwide drinking water mission project using its IRS 1A satellite image for mapping of groundwater potential zones. The improved spatial resolution of IRS LISS III satellite data was effectively utilised for aquifer management studies in selection suitable sites for construction recharge structure. In overexploiting groundwater terrain, integrated remote sensing study was carried out for sustainable groundwater planning and management. In the same terrain, remote sensing data were used for drought assessment. Remote sensing and GIS techniques were widely adopted in landslide hazard zonation mapping, vulnerability and risk assessment. In the recent years, the imaging spectroscopy and hyperspectral remote sensing plays vital role in geological mapping, especially on mineral exploration.

The imaging spectroscopy provides valuable information on remotely mapping of planetary surface. The remote sensing images are useful in mapping of minerals, rocks, elements and morphological features. The orbiter images like Clementine, Chandrayaan1 M3 data provided valuable information in the study of origin of lunar crust, highland region, impact craters and mare region. Similarly, the Martian remote sensing data like THEMIS, HiRISE, MOLA and MCC images provided global, regional and as well as micro level information on morphology, geomorphic processes, volcanism and fluvial activities. The recent planetary remote sensing studies on Moon and Mars are presented here.

GEOSPATIAL APPLICATION IN NATURAL RESOURCES MANAGEMENT

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Geospatial technology is going through technological evolution at a great pace over some decades, high precision and accurate mapping of natural resources are possible with latest development in the field of technology. Ground and surface water management, raw materials identification, draught monitoring, air quality monitoring can be done with the help of dedicated high precision tools. This paper deals with combination of various geospatial tools together in creating accurate predictions and monitoring of natural resources, which can further aid in the extraction of those resources. The three major tools which used in this paper are Remote Sensing (RS) Global Positioning Systems (GPS) and Geographical Information Systems (GIS) which makes the current study easier without minimal physical work and more analysis work in order to maximize the result and improve its accuracy. Normalized Difference Vegetation Index (NDVI) is the major parameter used to measure vegetation health obtained from MODIS, Terra satellite products MOD13Q1, MOD02QKM. The daily anomalies of NDVI from its long term mean NDVI over the same period was determined based on which drought risk classification was done. A digital elevation model (DEM) is a simple representation of a surface in 3-dimensional way with height as the third dimension. These high specific elevation data offers

enormous possibility for disaster management, hydrology and water management, geomorphology etc. Digital elevation models have the capability to evaluate the linear, areal and relief aspects of morphometric parameters in the GIS Environment. Watershed boundary, flow accumulation, flow direction, stream ordering; and contour, slope-aspect, hill shade have been prepared using ArcHydroTool; SurfaceTool in GIS software. Another important invention used in the field of geospatial technology is Spectroradiometer, which works by Spectrometer is an optical instrument that uses detectors other than photographic film to measure the distribution of radiation in 250nm – 2500nm of microwave spectral. One of the major advantage of using, Spectro-radiometer is that, it can record the spectra of samples without doing any pre-treatment or much of preparations. The sample readings are taken continuously, without doing much calibration along with providing the spectral graph instantaneously

Keywords: Geospatial; Satellite data; Hyper spectral; Natural Resource Management

EARTHQUAKES AND GEOLOGICAL STRUCTURES ALONG HIMALAYAN ARC

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The Himalayan Frontal Thrust (HFT) is the 2500 km long fault system that marks the active southward-verging collisional boundary of the Eurasian plate with the Indian subcontinent. The HFT generally marks the contact between sub-Himalayan sediments of the Tertiary Siwalik group and the Quaternary sediments of the Indo-Gangetic plain. Large magnitude, twentieth century earthquakes, including the 1905 Kangra, 1934 Nepal-Bihar, and 1950 Assam earthquakes, and historically documented earthquakes (e.g. 1255, 1344, 1505, and 1555) have likely ruptured the HFT. Defining the rupture segments and magnitudes of these earthquakes has been a challenge because of the scarcity of both historical records of the events and paleoseismic data.

There remains a clear need to investigate the morphology of the HFT fault scarps and document coseismic slip directly, as calculations of coseismic slip from scarp heights may introduce uncertainty (e.g. Jayangondaperumal et al., 2013). Boundary-element modeling

has demonstrated that a >20-m-slip event with a 1000 year strain accumulation is theoretically possible on the HFT (Feldl and Bilham, 2006). Alternatively, the large scarps along the HFT may represent two or more events instead of one surface-rupturing earthquake (e.g. Philip et al., 2012; Kumahara and Jayangondaperumal, 2013; Malik et al 2017; Rajendran et al., 2018; Jayangondaperumal et al 2018)

Earthquakes create geological landforms along active faults. These landforms can provide a clue for understanding the pattern of strain release and thus to propose recurrent time of great earthquake along Himalaya. To characterize the earthquake generated landforms, high resolution digital mapping together with field survey play central importance. In this talk, I will discuss briefly about effective use of existing digital data with shortcomings and how one can map the active faults along strike effectively where the vegetation covers are thick.

CRUST-MANTLE INTERACTIONS THROUGH TIME: CONSTRAINTS FROM THE RADIOGENIC ISOTOPES

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The geochemical complementarity of the crust and the mantle help understand the evolution of the silicate Earth through time. Studies of subduction zones on the present day globe have shown that a significant proportion of crust is generated as well as destructed at these sites. However, extrapolating these mechanisms of crust formation and destruction to the past has not always been straight forward.

This is mainly due to paucity of the rock-records for the older times, particularly for the early period of the Earth. Though there is hardly any proven Hadean rock-record, except the zircon grains, there has been a remarkable progress in recent years in understanding the Early earth processes using the Archean rocks, which in some instances carry the Hadean legacy in terms of the cryptic isotopic clues. One such isotopic system of ^{146}Sm - ^{142}Nd , with relatively short half-life of 103 My, has provided irrefutable evidences of the early silicate Earth differentiation older than 4.2 Ga. Coupled with the other short- and long-lived isotopic

systems, it has been demonstrated that mantle heterogeneities related to the early silicate differentiation could have survived, at different spatial scales, for the billions of years.

These understandings led to the revival of the debate on the mechanisms of crust-mantle interactions. It is now largely believed that Plate Tectonics, as we see it today might not have been the mechanism during the early period of the Earth. There is a wide spectrum of models that are being proposed today to explain the crustal and mantle records of the early Earth. On one hand it is suggested that significant proportion of the crust, that we see today, must have been extracted earlier than > 3.2 Ga when the mechanism of Plate Tectonics started taking the crust back to the mantle while on the other hand it is also hypothesized that a steady-state of Plate Tectonics did not get established till the end of the 'Boring Billion' in the Neoproterozoic.

In this talk, I would discuss the premise of some of these models in light of the results that we obtained recently using the short-lived isotopic system.

MONSOONS: ROLE OF OCEANS

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The Indian economy is primarily dependent upon agriculture and hence spatial distribution of rainfall over the Indian subcontinent is a matter of grave concern. Most of the meteorological sub divisions of the subcontinent receive over 75–90% of the mean annual rainfall during the summer monsoon season (June–September). The south east peninsular India receives a reasonable amount of rainfall during the post monsoon season (October-December). In addition to the large inter-annual variability in the amount of monsoon rainfall, there is large intra-seasonal variability, which determines the capacity of the monsoon to provide a water resource useful for agriculture. A positive rainfall anomaly of 11.2% translates into 8% food grain production for India (WMO, 1997).

The summer monsoon exhibits large variability in three important aspects. They are:

- Onset of Monsoon over the Kerala coast (MOK);

- Different phases of monsoon activity within the life cycle of the monsoon (active, weak and break in monsoon conditions), and,
- The amount of rainfall received during the monsoon season.

In the present study, we would like to bring out the role of the various Ocean Atmospheric Processes on the all the above three important aspects of the Indian Summer Monsoon, using a suite of data sets such as in situ, satellite and Reanalysis products. Further, we also look into the role of El Nino, La Nina, IOD etc on the monsoon activity over the Indian Subcontinent.

VISUALIZING 2018 FLOOD OF CENTRAL KERALA, INDIA, THROUGH SATELLITE

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Kerala, a state in southwestern India, recorded 24% excess rainfall than normal levels from June 1 to September 30 2018, leading to widespread floods and landslides events and resulting in 445 deaths. Data on the extent of flooding need to be captured before the water recedes or else the spatial data on floods will be perished. Cloud-penetrating, active radar sensors operating in the microwave region, is the best and plausible way for flood inundation research, regardless of cloud coverage. In this study, satellite-based data were used to map the flood inundation in the highly affected Kuttanad area in Central Kerala, India. Specifically, flood delineation was enabled with RADARSAT-2 and Sentinel-1A radar data of August 18, August 21, August 27, September 2, September 14 and September 26, 2018 and was compared with an average pre-flood, water-cover map based on Modified Normalized Difference Water Index (MNDWI) that was developed using a 29 January 2018 Sentinel-1A dataset. A 178.8% increase in water cover was observed during the August 2018 deluge. Low lying areas in the coastal plains of Kuttanad has marked a rise of up to 10 m of water on

18 August 2018 and has reduced to 5 m on 21 August 2018. These estimates are conservative as the peak flood spanned both 17 and 18 August 2018.

Keywords: 2018 anomalous rainfall, Kerala flood, RADARSAT-2, Sentinel-1A

DISTRIBUTION OF RECENT BENTHIC OSTRACODA FROM THE COAST OF TAMIL NADU: IMPLICATIONS ON TAXONOMY, SILTATION, HIGH ENERGY EVENTS AND MICROENVIRONMENT – AN OVERVIEW

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Ostracods, the tiny Crustaceans, are generally around one mm in size and protected by a bivalve calcareous shell, the Carapace. They inhabit different ecological niches as majority of them live in marine and brackish water, while others in freshwater and moist terrestrial environment. The significant controlling factors governing the ostracod distribution in estuarine environments and continental shelf zones are salinity, water temperature and substrate. Despite, some ostracod species are sensitive to the most subtle changes in their environment, others are capable of withstanding a wide range of conditions, even to the extent of inhabiting heavily polluted sites. Though, India is having a long coastline of about 7,500 km and Tamil Nadu state with a coastline of about 1,000 km with various marginal marine water bodies, the studies on Recent Ostracoda are still in infancy.

In this paper, a brief overview of the taxonomy and biodiversity of Ostracods carried out from the coast of Tamil Nadu from north to south selecting the shallow marine areas (open sea environment) viz., from off Karikattukuppam (near Chennai); off Tuticorin; off Rameswaram; and marginal marine locations viz., Ennore creek; Adyar river estuary; Pitchavaram mangrove; Mullipallam creek and Tamiraparani river estuary has been presented. The biodiversity index ranges from 26 to 75 representing a minimum diversity in the Adyar river estuary while the maximum diversity from off the coast of Tuticorin. A total of 167 species of

marine, 38 species of brackish water ostracoda have been identified from the coast of Tamil Nadu which include 6 new species. From the zoogeographic distribution of the ostracods of Tamil Nadu coast, it is inferred that the fauna has got a strong Indo-Pacific affinity with the following species appear endemic to the east and west coasts of India such as *Hemicytheridea bhatiai*, *Jankeijcythere mckenziei*, *Kalingella mckenzie*, *Neomonoceratina jainii* and *Neosinocythere dekrooni*. Carapace- Valve (C/V) ratio, predation, colour pattern and ornamentation of the carapace were utilized to study the microenvironment of the area. From the C/V ratio of ostracods, a comparatively rapid rate of sedimentation (high siltation) is observed in many localities of Tamil Nadu coast, which can be attributed to more number of streams/rivers flowing and debouching the sediments into the Bay of Bengal such as Cauvery, Tamiraparani and their distributaries.

The high energy events such as storm and tsunami and also the sediment provenance associated with the tsunami deposits can be recognized in the stratigraphical record from the distribution of the microfossils viz., Foraminifera and Ostracoda. Sediment sub-samples recovered from the trench of almost 1 m located 500 –700 m away from present day shoreline at Kameshwaram, near Nagapattinam, Tamil Nadu, Southeast Coast of India, show lithological variation and the occurrence of microfossils typical of shallow marine (offshore) regions.

The colour of the ostracods recovered from many marine and marginal marine localities of Tamil Nadu coast, from white and pale yellow indicate that the sediments are deposited under normal oxygenated conditions. The surface sculpture of the ostracod also reflects on the grain size of the sediments and the environment in which these tiny Crustaceans thrive. Similar studies have also been made from all the study areas of Tamil Nadu coast and the interpretations have been presented in this paper. The present ecological and environmental data may also be used for the interpretation of paleo-microenvironmental niche. As a sequel, I would like to emphasize that the vast Indian coast provides a lot of scope to work on Ostracods, as these days' it is very hard to find the fundamental taxonomists. The functional morphology, biogeochemical and stable isotopic and statistical knowledge of Ostracods are

few potential areas for future studies through the collection of shallow to deep cores to unravel the pollution, paleoclimate and other related microenvironmental inferences.

LANDSLIDE MANAGEMENT IN KERALA

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Kerala state of which 47% is occupied by most prominent orographic feature of Indian Peninsula, the Western Ghats. The hill ranges of Kerala experiences several types of slope failure of which debris flows are the most common. The west facing Western Ghats scarps that runs the entire extent of the mountain system is the most prone physiographic unit for landslides (Thampi et al 1995)

Unprecedented occurrences of innumerable devastating slope failures resulting in extensive damage to life, property and environment were reported throughout the hill ranges of Kerala during 2018 monsoon period. Though rainfall is the triggering factor for all the incidences, the proneness of the region to slope failures has increased due to anthropogenic disturbances such as deforestation and unscientific slope modification. A combination of factors may be blamed for the landslides that happened and likely to repeat particularly during two or three days of excessive rain in a monsoon season. These unusual rainfall episodes in a normal monsoon period will be on the rise in future as part of the climate change. In this context landslide hazard zonation form the basic tool for management of landslide risk.

In the present study attempts have been made to prepare landslide hazard zonation map of Idukki District. The map was generated using causative factors such as slope, relative relief, aspect, curvature, drainage density, drainage frequency, landuse, roads buffer and drainage buffer. About 65% of the slope failures coincide with the critical and highly unstable zones marked in the landslide susceptibility map. Experiences reveal that the macro landslide zonation alone is not sufficient to mitigate the effects of a disaster. Site specific studies should be conducted in high risk zones which are already demarcated in landslide susceptibility map. Debris flow, subsidence, slab slide, landslide, rock fall and slump are the common type of the

hill slope failure found in Kerala Western Ghats. Initially, failures could have occurred as small cracks slips on cut slopes. With passage of time, these failures have retrograded and attain large dimensions causing extensive damage. Cracks/ slips are all indicators of a major event and can be considered as an “aborted landslide”. Many hill slopes registered this kind of lengthy criss cross cracks, soil piping (underground tunnel erosion) was also wide spread in many locations during 2018 monsoon.

The lessons learned from the previous experiences stress the need for a site specific investigation in high risk zones of hill ranges. From the field observations the main causative factors attributed to the various landslide events includes

- Steep cutting made for road/ building construction resulting in day lighting of rock/ overburden interface. The unsupported cut cliff slope resulted in slope failures due to increase in pore water pressure when prolonged and excessive rainfall exist.
- Presence of dense trees along the edge or crown of the cut lopes resulted in increase of load at the marginally stable cut face. The roots penetrating through the loose and exposed over burden have shattered the soil mass; thus facilitating the faster ingress of rainwater. The process in turn resulted in loosening of the overburden, which failed at many locations during rains. This is evident from the presence of trees in the debris. In some instances, fire has transformed the thick forest area in to degraded patches. This act as a catalyst for the onset of slope failures.
- Unscientific land use practices such as terracing and contour bunding in steep hill slope for plantation activity has altered the micro drainage existed along the slope. This along with preparation of rain water pits and pits for rubber saplings has increased the storm water infiltration rate.

- Blockage of natural drainage courses for the purpose of settlements has led to damages.
- Absence / insufficient number of surface water drainage lines to drain out the storm water as many first order streams were obliterated for plantation and human settlement.
- Unscientifically constructed culverts for excess storm water discharge. Water diverted through these culverts erodes away the loose material in the hill slopes resulting in filled slope failures.

From the study we conclude that majority of the slope failures are the result of unscientific human interferences.

Important remedial measures suggested containing the slope failures are

- Preparation of landslide hazard zonation map and risk map. Landslide susceptibility study along the major road corridors of hill districts is to be carried out to identify the vulnerable zones.
- Future hill slopes modification must be carried out scientifically after considering the slope stability and geo engineering aspects.
- Vulnerability of the cut slopes can be reduced by using appropriate mitigation options, such as reinforcement of the cut slope with properly engineered retaining structures.
- Proper land use practice must be followed especially along the vulnerable slopes. Terracing and contour bunding should not allow along the steep slopes. People living in highland areas must educate about the importance of proper land use practices minimize the risks.

- All the natural drainage channels must be preserved, during peak monsoon season more drainage channels may be developed especially along the terraced slope to drain out the storm water.
- Benching of crown slope can be done in some of the areas to reduce the risk.
- Blasting in quarries can widen the preexisting cracks/ joints and more water can be infiltrated in to these cracks. During storm excess water collected in the cracks build up pressure and reduces the intact nature of the litho unit. Ban quarries in highly hazardous zones of landslide hazard zonation map published by Kerala State Disaster Management Authority.

CHARACTERIZATION AND COMPARISON OF TSUNAMI AND CYCLONE DEPOSITS FROM SOUTHEAST COAST OF INDIA

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Catastrophic events are takes place very rarely in the earth history and often they leave geological signatures which differ in its characteristics from the records of normal cyclic processes. In view of this catastrophic nature of the geologic records the aphorisms of modern geologists depend both on catastrophism and uniformitarianism. The catastrophic events may also have Decadal to Millennium-Scale geological records. The tsunamis and cyclones are such catastrophic events which leave deposits that have been identified and described by many geologists globally from many siliciclastic coastlines. Identifying these past catastrophic events will help as in proper disaster management framework. However differentiating these past coastal flooding events remains a great task. Storm and tsunami deposits have been identified and described from many siliciclastic coastlines globally, but

detailed comparison of both known storm and tsunami deposits from the same coastlines are lacking. In this study the sediments deposited by 2004 Indian Ocean Tsunami, Cyclone Thane, Cyclone Hudhud, Cyclone Phailin, Cyclone Gaja have been studied in detail and were compared. In two locations cyclone and tsunami deposits were identified from the same pit. Sediment deposited by Cyclone Thane were superimposed on Indian Ocean Tsunami sediments in Cuddalore. Sediment deposited by Cyclone Gaja were superimposed on Tsunami sediments near Nagapattinam. The deposits were examined at 1cm increments for grain size, grain shape, heavy minerals, X-ray diffraction, X-ray fluorescence and microfossils. A suite of statistical analyses, including exploratory data analysis, ANOVA, principal component analysis (PCA) and discriminant function analysis (DFA) were used to compare the measured parameters and the individual deposits within and between different locations. Individual deposits showed significant differences in many of the parameters, but no individual variable was diagnostic of the deposits.

ORAL PRESENTATIONS

LANDSLIDE SUSCEPTIBILITY EVALUATION IN SOUTHERN WESTERN GHATS: A COMPARATIVE STUDY USING FREQUENCY RATIO, EVIDENTIAL BELIEF FUNCTION AND MULTIVARIATE LOGISTIC REGRESSION METHOD

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The western flank of India forms a passive continental margin, where the great escarpment extending parallel to the western coast of India is known as the Western Ghats. The windward slope of Western Ghats has been identified as a hotspot for the occurrence of repeated cataclysmic landslide events. The Western Ghats covering the state of Kerala has witnessed an immense deluge and associated landslide events in the recent past. Majority of the landslide events associated with the flood incident of 2018 are the results of anthropogenic disturbances in the hilly tracts of Western Ghats and this stresses for more accurate methods and models for landslide susceptibility analysis. The main aim of the present study is to compare three different statistical methods which are commonly used for landslide susceptibility mapping and to find out more accurate and suitable method for landslide susceptibility modelling in the southern Western Ghats of Kerala. For this purpose, a landslide inventory map of 82 landslides were prepared and randomly divided into 70-30% basis for training and validation. Thereafter twelve landslide conditioning factors such as lithology, geomorphology, land use/land cover, soil texture, slope angle, slope curvature, topographic wetness index, relative relief, distance from the road, distance from the streams, distance from the lineaments and annual average rainfall were extracted from spatial databases and multi collinearity among the variables were checked. Finally the landslide susceptibility modeling was done using Frequency Ratio, Evidential Belief Function and Multivariate Logistic Regression methods. The model was validated using ROC-AUC techniques, where evidential belief function shows best performance in success rate with 83% accuracy. Therefore the study proposes the use of EBF in landslide susceptibility modeling in southern

Western Ghats for better accuracy. The generated models are trust worthy for future land use planning.

Keywords: Western Ghats, Landslide susceptibility, Frequency ratio, Evidential Belief function, Multivariate logistic regression.

AN INTERPRETATION OF MID- LATE HOLOCENE PALEOENVIRONMENT USING SEDIMENT DEPOSITS OF N-W KERALA COAST, INDIA: SIGNIFICANCE OF FORAMINIFERAL AND SEDIMENTOLOGICAL SIGNATURES

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Abstract

Based on field documentation, we produce a comparative analysis of soft sediment deformation and other sedimentary signatures indicative of sea level changes at two sites on the Northern Kerala, West coast of India. Pit profiles from these sites depict major differences in morphology of the structures and presence of benthic foraminifera as a result of greater over pressure from terrigenous deposition and Marine input at Kizhakke-kandangali parappa (KK Parappa) and Marayikode. Different features such as the variability of the local assemblages, population density, species diversity, age population structure suggests that these microorganisms may be included amongst the most promising tracers of these high-energy events in marshes, lakes, lagoons or shallow marine areas. The results of two pits sediments radiocarbon dated are 4650±100 yrs BP; 4950±130 yrs BP; and 5435±130 yrs BP from KK Parappa and shell dates range from 5100 ± 100 yrsBP . At Marayikode pit three sediment samples and shell were ¹⁴C dated 5730±120 yrs BP; 5300±80 yrs BP; 5650±100 yrs BP and 5600±80 yrs BP. The results present that sediment deposits and shell layer debris below the surface, which has a marine connection with terrestrial margin. Similarly the sedimentation rate is considerably controlled by the river and terrestrial input because the rate of sedimentation is higher in transition time compared to Holocene period.

Keywords: Sea level changes, Benthic foraminifera, sedimentology, ^{14}C Dating.

GIS BASED STUDY ON MORPHOMETRIC CHARACTERISTICS AND HYDROGEOLOGICAL BEHAVIOUR OF KALLADA RIVER BASIN, SOUTH KERALA

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Abstract

The morphometric analysis of drainage basins should receive more attention in hydrological as well as hydrogeological investigations. Geographical Information System (GIS) techniques are now widely used for assessing various terrain and morphometric parameters of the drainage basins. The objectives of the present study are to analyse the linear, areal and relief morphometric attributes of Kallada drainage basin and its fourth order sub-basins and to deduce correlation if any between these parameters using Geographical Information System. The drainage basin is divided into 58 fourth order sub-basins and morphometrical parameters such as linear aspects, aerial aspects and relief aspects of these were assessed. The study shows that Kallada river basin and its sub-basins are characterised by a complex physiography and structure. The morphometric parameters such as drainage density, stream frequency, drainage texture, basin relief, relief ratio, ruggedness ratio, gradient ratio, Melton ruggedness, length of over land flow and constant channel of maintenance exhibit satisfying correlations with groundwater potential zones in the area.

Key words: Groundwater, GIS, Morphometry, Kallada River basin, drainage basin

LAST GLACIAL TO HOLOCENE ABUNDANCE VARIATIONS IN THE TWO MORPHOTYPES OF *GLOBIGERINOIDES RUBER* IN THE ANDAMAN SEA

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Abstract

Globigerinoides ruber, a tropical to subtropical species which dwell in the mixed layer, has gained much attention for palaeoceanography especially for isotope and elemental based reconstruction of sea surface temperature and salinity. *G. ruber* has two morphotypes, *G. rubersensustricto* (s.s.) and *G. rubersensulato* (s.l.), represent two groups with different depth habitats in the mixed layer. These two morphotypes together constitute nearly 10 to 30 % of the total planktonic foraminiferal abundances in the tropical to subtropical Ocean and make it as a potential proxy for paleoceanography. The isotopic (oxygen and carbon) and elemental ratios (Mg/Ca) of planktic foraminifera *G. ruber* from the marine archives are widely used as a proxy for reconstructing past sea surface temperature, ice-volume changes etc. But recent geochemical studies on *G. ruber* morphotypes have shown that the differences in seasonal calcification depths between these two morphotypes could potentially be biased in the reconstructions using a non-selective mixture. In contrary, a very recent a study from the Gulf of Mexico, has shown that there is no evidence for discrepancies in *G. ruberss-sl* calcifying depth habitat. In this context, we have analysed the abundance variations of *G. rubers.s.* and *G. rubers.l.* from a core retrieved from the northern Andaman Sea for better understanding the changes in mixed layer thickness in response to monsoon evolution from last glacial to Holocene. The downcore abundance variations of these two morphotypes were compared with other monsoon, and productivity proxies and paleoceanographic inferences are discussed in detail.

Keywords: *Globigerinoides ruber* morphotypes; mixed layer; monsoon; oxygen isotope; Andaman Sea

COMPARATIVE STUDY OF ENDMEMBER EXTRACTION TECHNIQUES FOR A BETTER MAPPING OF HYDROTHERMAL ALTERATION MINERAL ASSEMBLAGES

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Abstract

End member extraction from a hyperspectral data is one of the most crucial and critical step for the mapping the objects from the image. There are several methods of extraction of “pure” end members from the image and the results of the classification depends on the end members extracted. In this study, we compared the end member extraction using two popular methods of endmember extractions namely Pixel Purity Index (PPI), and Sequential Maximum Angle Convex Cone (SMACC) from the Airborne Visible InfraRed Imaging Spectrometer – Next Generation (AVIRIS-NG) hyperspectral data covering parts of Hutti – Maski Schist Belt (HMSB), one of the auriferous deposits in India. The data has 425 bands from 375 nm to 2500 nm, at 5 nm interval, at a spatial resolution of 7.3 m. The data covers Tuppadur – Buddinni block, of HMSB. The alteration region contains chlorite, clay minerals such as illite, montmorillonite, biotite, muscovite, and in general quartz and feldspar, which constitutes the altered chlorite schist. Whereas the unaltered region is made of amphibolites, generally made of amphibole minerals such as hornblende and tremolite with minor chlorite, with quartz and feldspar. L2 Reflectance data, provided by NASA was processed in ENVI software. Prior to the end member extraction, band bands were removed and noise removal was carried out by applying Minimum Noise Fraction (MNF) transformation, Inverse MNF rotation was carried out using 14 MNF bands and used for further analysis. End members were extracted using PPI algorithm, which gives an output where the pixel that was returned maximum number of times as unique being the brightest, and to the darkest. The brightest pixels are called the Purest Pixels, which cannot be broken down as the constituents any further. These pixels are then visualized the n-Dimensional (n-D) visualizer where similar clusters of pure pixels are grouped into one class and the resultant spectra were derived. The spectra were examined and only those corresponding to lithology, soil and alteration zone are retained for the comparison purpose. 23 endmembers were derived out of which, 10 endmembers had signatures of geological parameters, though some of them are low and some are kind of repetitive. The end members were also extracted using SMACC algorithm, where the endmembers are derived

using Residual Minimization model. The difference between PPI and SMACC is that the Former gives a lot of pixels, whereas the latter gives a single pixel, which is an approximated representative of the group or class in consideration. Similar to PPI, only those end members corresponding to lithology/soil were retained which amounts to 9 unique endmembers, out of 37 endmembers. Spectral Angle Mapper algorithm (SAM) was used for mapping the region using the end members derived from both the methods and accuracy assessment was done. SMACC gave better number of geological endmembers than that of PPI, which is more crucial while doing mapping of mineral assemblages.

GEOSPATIAL APPROACH FOR MACRO ZONATION OF LANDSLIDE HAZARDS IN KOZHIKODE DISTRICT, KERALA.

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Abstract

The Hill ranges of Kerala are vulnerable to various types of slope failures, particularly during monsoon season. The large-scale anthropogenic activities, which are often carried out unscientifically without considering the inherent adverse aspects may further increase the chances of failure. During the development of new communication arteries, urbanization and implementation of mega projects impact on landuse and the insitu geological and geotechnical parameters are not often taken into consideration. The present study deals with macro zonation of landslides hazards using Remote Sensing and GIS in Kozhikode district (scale 1:50000). A numerical weightage to the causative factors of slope instability viz. Slope, Relative Relief, Aspect, Curvature, Drainage density, Drainage frequency, Landuse / land cover, Road buffer and Drainage buffer are assigned as per earlier workers for the purpose of landslide hazard zonation. The area depicts zones of different susceptibility to failure. 10.06% of areas come under critical and highly unstable category. The risk depends on the location of the hazardous slope. Therefore, landslide risk map is prepared in the Panchayath level. The critical areas in each Gramapanchayaths are demarcated. Kurachund Gramapanchayath has the maximum percentage of hill slope falling under highly unstable and critical zone together. This is followed by Koodaranji, Thiruvambadi, Chakkittapara,

Kaavilumpara, Puthupadi and Kodencheri. This risk map can be used by panchayth officials for making disaster preparedness.

TEXTURAL CHARACTERISTICS OF SEDIMENTS AND WEATHERING IN THE BHARATHAPUZHA RIVER BASIN, KERALA

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Abstract

Continental weathering is a major geological process responsible for landscape evolution and exerts a major control on the transport of eroded materials from continents to the oceans and on the cycles of many chemical elements, including carbon, at the earth's surface [1]. Grain size studies provide important clues to the sediment provenance, transport history and depositional conditions. Geochemical studies of the bottom sediments of rivers are very helpful in understanding the different sediments sources, element distribution pattern and evaluating the existing environmental conditions in an area. In the past few decades, textural and geochemical studies of sediments have been a subject of intense research. Here an attempt is made to determine the texture, grain size distribution and geochemical nature of sediments of the Bharathapuzha river (10°25' to 11°15' N and 75°50' to 76°55' E), the second longest (209 Km) among the west-flowing perennial rivers in Kerala. Bharathapuzha and its tributaries. An attempt has also been made to use the statistical tools like contamination factor (CF), index of geoaccumulation (Igeo), to assess the heavy metal pollution.

The textural studies clearly established that the sediments were dominantly of gravel to fine sand, poorly sorted to moderately well-sorted and symmetrically skewed. The kurtosis suggested very platykurtic to leptokurtic nature of sediments. The sediments were deposited under moderate to low energy conditions with dominant rolling processes. The statistical parameters showed little spatial as well as temporal variations. The observations are supported by the frequency curves and bivariate plots between various textural parameters,

confirming the polymodal nature of sediments with dominant to moderate sand fraction. The bimodal and unimodal nature of the sediments was also present at certain locations. The major oxide elemental chemistry of the sediments indicated that the dominant elemental oxide was SiO_2 followed by Al_2O_3 in all the sediments. The Chemical Index Alteration (CIA) and Resistant Index of Maturity (RM) reflected mostly unweathered to weakly weathered and immaturity of the sediments in the basin. The CF values of all the metals in the Bharathapuzha falls in greater than one or below one, indicating low to high degree of contamination of heavy metals. The index of geoaccumulation of Bharathapuzha river sediments falls in the Igeo-class of zero and between 0 to 1 indicating contamination or moderately contaminated of the metals like Fe, Mn, Cu, Cr, Ni and Zn in the sediments of the systems.

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IMPLICATIONS FOR FLUVIAL AND GLACIAL PROCESSES FROM EOS CHAOS REGION OF VALLES MARINERIS, MARS

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Abstract

Valles Marineris consists of complex Martian morphologic features including Chasmata and Chaotic terrains. Chaotic terrains are circular or semicircular troughs which contain mounts and rock fragments. Western part of Eos Chaos region of Valles Marineris is a semi-circular trough. The Eos Chasma and Capri Chasma located towards the east of Valles Marineris are well-known for the presence of evidences for Hesperian aqueous processes [1]. The Eos Chaos region is closer to the above mentioned chasmata. The Eos chaos region of the Valles

Marineris (with the central latitude and longitude 16.82° and 313.48° respectively) is investigated for morphology and mineralogy using data sets of Mars Color Camera (MCC) onboard ISRO's Mars Orbital Mission (MOM 1) [2], CTX (Context Camera) and HiRISE (High Resolution Imaging Science Experiment) onboard NASA's Mars Reconnaissance Orbiter (MRO). Digital Elevation Model (DEM) is generated using the available CTX stereo pairs with the help of MarsSI tool [3]. Spectra from the available CRISM hyperspectral data are compared with CRISM and USGS spectral library data to identify the minerals from the study region. The CRISM summary parameters are also used to understand the mineralogical variations [4].

Presence of tongue shaped viscous flows of various phases; pit cum knob structures, brain terrains, Lineated Valley Fill (LVF) etc. hints the past and present glacial processes. The glacial movements have played significant role in the evolution of the western half of the study area. While a number of morphological features such as channels, deltas at channel mouth and near circular depressions with deltaic deposits on their floor (inferred as paleo-lakes) are identified from the other half of Eos Chaos. A few evidences for regional scale tectonic movements have also been identified from the study area. The segments of wall rocks and channels are shifted relatively from the remaining part of the feature by the tectonic process. Evidences for stream piracy caused by this tectonic movement are also identified. Hydrated minerals and primary rock forming minerals were identified earlier from this region. Apart from this a low-grade metamorphic mineral zoisite (characteristic absorption band at $1.65\text{ }\mu\text{m}$) is also detected from the study area [5]. These morphological and mineralogical features turned Eos Chaos as a unique area for future exploration.

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HYDROCHEMISTRY OF GROUNDWATER IN THE LOWER REACHES OF KARUVANNUR RIVER BASIN, CENTRAL KERALA, INDIA

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Abstract

Quality of water is more important than quantity in certain situations like urban and coastal areas. There are two main areas of concern with groundwater usage, one maintaining the quality and the other is ensuring sustainable quantity. Groundwater system along the low-lying areas especially along the coastal stretches of Kerala are very sensitive due to the chances of saline water ingress. Lower reaches of Karuvannur River basin in Thrissur District of Kerala is such an area. The hydrochemistry of groundwater from the Lower Reaches of Karuvannur River Basin of Central Kerala has been studied during the pre-monsoon and monsoon seasons. The present study mainly aims to investigate and compare the seasonal variation of hydrochemical parameters during these two periods. Groundwater samples were collected from 27 open wells during the months of April and July 2016. These Samples were analyzed for various physico-chemical parameters such as pH, electrical conductivity (EC), Na⁺, K⁺, Ca²⁺, Mg²⁺, alkalinity, hardness, chloride, salinity, total dissolved solids (TDS) and sulphates (SO₄²⁻). Chemical analysis of the collected groundwater samples were carried out using the standard procedures as per APHA [1] at the Isotope Hydrology Division, CWRDM. Temporal and spatial variation pattern of water quality in shallow aquifers has also been investigated. The study area covers nearly an area of 300 km² and having mainly three geological lithounits namely Coastal sand and alluvium, Hornblend gneiss and

laterite. The availability as well as the quality of groundwater depends upon the characteristics of the country rock.

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GEOSPATIAL AND GEOLOGICAL EVALUATION OF LANDSLIDES OF MALAPPURAM, KERALA.

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Abstract

Landslides are natural processes, usually triggered due to excessive rains; sometimes turn into hazard causing damage to nature, man-made structures, and loss of lives. In recent past, the state of Kerala has witnessed several occurrences of landslides, mostly restricted to the highland regions. Along with the recent floods occurred in August 2018, landslides were also triggered at several parts of the state. Therefore, it is high time to conduct landslide hazard assessment for risk management and hazard zonation. In this paper, we discuss about the recent landslide occurrences of Malappuram District induced due to excessive rainfall and evaluate the hazard with regards to geospatial and geological aspects. In Malappuram, most of the landslides are concentrated on high land regions of the district, such as Nilambur and Ernad Taluks. The worst-affected areas are Nilambur, Edavanna, Areekode, Cheekode, Vazhakkad, Vazhayoor in Kondotty. The study has been carried out with the help of applied remote sensing and geographic information system (GIS) techniques. Overlay analysis of various thematic layers are used for the study. On a first look it seems that localisation of landslide into certain pockets is caused by intensified mining activities in the area. This aspect is also investigated in detail in the present study.

ESTIMATION OF REFERENCE EVAPOTRANSPIRATION UNDER LIMITED METEOROLOGICAL DATA

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Abstract

In recent days Tamilnadu in general is facing water shortage for agricultural purposes. Management and utilization of water resources mostly depends upon the spatial and temporal distribution of rainfall and evapotranspiration. General practices for estimating evapotranspiration are to first estimate Reference Evapotranspiration (ET_o) and then multiplying by corresponding crop coefficient. Several empirical equations for ET_o estimation have been proposed; they should be evaluated for local conditions before being used. The International Commission for Irrigation and Drainage and FAO have recommended using the Penman–Monteith model as the standard method for estimating Reference evapotranspiration. However, Penman–Monteith model requires climate variables such as temperature, wind velocity, relative humidity, solar radiation etc. Unfortunately, there are a limited number of meteorological stations where these climatic variables are measured, in developing countries like India. In such situation, the procedure for estimating evapotranspiration outlined by Hargreaves et al. 1985 is more suitable. The Hargreaves model requires only extraterrestrial radiation, daily mean, maximum and minimum temperature, usually available at most meteorological station or derived from MODIS Land Surface Temperature (LST) data. Many previous studies confirming that Hargreaves model produce satisfactory results in computing weekly or monthly ET_o. In this study an attempt has been made to compute ET_o over Thamirabarani basin, Tamilnadu, India using Hargreaves model and compare the relative performance with Penman–Monteith model. For the Hargreaves model, MODIS-LST data are employed for predicting maximum and minimum temperature over the study area for the period of 2015. The meteorological observatory data located over the study area at Cheranmadevi is employed for estimating ET_o by Penman–Monteith model. The correlation coefficient of the ET_o computed is 0.9. The average error and average root mean square error are 0.25 mm/day and 0.63 mm/day respectively between

the two models. The results of the study encourage the application of the Hargreaves model in the semi-arid region of Tamilnadu, India when the data short condition.

GEOCHEMISTRY OF PROTEROZOIC GRANITES OCCURRING ALONG THE WESTERN MARGIN OF NELLORE SCHIST BELT

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Abstract

The area around Rapur has been mapped on 1:25,000 scale in the southern part of Nellore schist belt to establish the contact relationship between the various litho-units. The dominant lithology exposed around Rapur area is Nellore Schist Belt (NBS) on the eastern side, Nallamalai Fold Belt (NFB) on the western side and major granitic-gneiss, granitoids exposed, are sandwiched between NSB and NFB. The different granite variants exposed in the area are migmatite / Tonalite Gneisses of Tonalite Trondhemiite Granodiorite (TTG) suite, hornblende-biotite gneiss and orbicular granite which are parts of the Tonalite-Granodiorite-Monzonite (TGM) suite and alkali feldspar-granite and undeformed younger granite of the Monzo-Granite/ Syeno Granite (MS) suite. Mineralogically, these granitic suites mainly consist of plagioclase, K-feldspar, quartz as felsic phases while biotite and hornblende forms mafic constituents. Apatite, monazite, zircon, epidote, zoisite occur in accessory amounts. These granitoids show chemical similarity, suggesting their formation from a similar source but at different events, especially the TGM & MS suite. The granitoids characterized compatible trace elements, Ti, Zr, CaO, FeO, MgO and high Sr and Ba concentrations. The mineralogical heterogeneity is reflected in the major and trace elemental abundance. Predominantly the gneisses are tonalitic to granitic in nature, with low-moderate Rb and high Sr contents, show calc-alkaline affinity with high K₂O percentage and a metaluminous nature. The granites characteristically show enriched LREE, relatively flat to somewhat depleted HREE chondrite normalized REE patterns with significant strong negative Eu anomalies. LREE enrichment, strong negative Eu anomaly and flat HREE patterns in these granites

indicate an enriched lower crustal source. In the tectonic discrimination diagram Y vs. Nb and Y+Nb vs. Rb, samples plot in Within-Plate-Granite (WPG) field. The overall geochemistry of the granites suggest that these granites are of late –anorogenic in nature.

Keywords: Nellore Schist Belt, Tonalite Trondjhemite Granodiorite (TTG), Tonalite-Granodiorite-Monzonite (TGM), Monzo-Granite/ Syeno Granite (MS).

MORPHOLOGICAL AND MINERALOGICAL CHARACTERIZATION OF DAS CRATER ON THE FAR SIDE OF THE MOON

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Abstract

The study of well-preserved young Copernican craters on Moon is of utmost importance for a better understanding of recent lunar geological processes. Das crater is a Copernican aged complex impact crater located on lunar farside, centred at approximately 26.48° S and 137.00° W. Das crater shows several peculiar geological features, making this region an interesting candidate. We have investigated Das crater in terms of its morphology and surface mineralogy to understand the origin and process of formation of various lithologies associated with distinct morphologies. Data from ISRO's maiden Lunar mission Chandrayaan-1, particularly TMC (Terrain Mapping Camera) at 5m/pixel, LROC-WAC (Lunar Reconnaissance Orbiter Camera-Wide Angle Camera) at 100m/pixel and M3 (Moon Mineralogy Mapper) have been used for the morphological and mineralogical characterization. Morphological features have been identified in unprecedented detail using high resolution LROC-NAC (Lunar Reconnaissance Orbiter Camera-Narrow Angle Camera) imagery at 0.5m/pixel. Softwares like ENVI, ArcMap, and OriginPro have been utilised for data processing and analyses. Spectral deconvolution for an intriguing extensive melt deposit of Olivine on the eastern wall of Das crater was carried out using Modified Gaussian Model (MGM)[1]. Spectral band minima for pyroxenes were calculated by fitting polynomials of high order to maximum possible number of discrete data points of the absorption feature [2].

Morphological mapping of central peak region, scarp, tread, hummocky floor terrain, melt deposits have been carried out. Mineralogical mapping yielded a first estimate of mineral abundance. A detailed compositional analysis has shown that Ca# of pyroxenes range from 0 to 25%. Analysed pyroxene spectra show a nearly uniform composition, mostly pigeonites. Two-pyroxene thermometry revealed temperatures of crystallisation of the impact melt deposits in 1100°-1250°C range [3]. Olivine rich melt on the Eastern wall of Das crater is forsteritic (Fo# = 86), implying primitive (non-evolved) magnesian magma crystallisation. We will further discuss the evolutionary aspect of Das crater.

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BENTHIC FORAMINIFERA AND GEOCHEMICAL ASSESSMENT OF ANJUTHENGU ESTUARY, THIRUVANANTHAPURAM, SOUTH WEST COAST OF INDIA

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Abstract

Foraminifera are better known for their spectacular fossil record than their variety of abundance in modern marine environments. Foraminifers, being sensitive to minute changes. The characteristics of foraminifers to incorporate the signature of presence of pollutants are considered to be an effective tool for temporal pollution monitoring studies. Totally, 20 grab samples, 20 water samples and 3 core samples has been collected from the Anjuthengu estuary, Varkala, Thiruvananthapuram district, (both Pre and Post Monsoon) for distribution of foraminifera and pollution studies. Apart from foraminiferal studies, geochemical studies of the sediments are also undertaken to correlate and substantiate the findings.

In Anjuthengu estuary, 50 foraminifera taxa belonging to 24 genera, 16 families, 9 super families, and 5 suborder have been identified in surface sample and in core sample 11 foraminifera taxa belonging to 9 genera, 6 families 4 superfamilies and 3 suborders have been identified and the following genus Ammonia, Elphidium, Triloculina, and Quinqueloculina are dominates the total assemblage. Sedimentological studies reveal that organic matter and calcium carbonate content of the samples are relatively high and the substrate consist of silty sand followed by sand in nature but in core most of the sample consist of sand in nature. The bottom water measurements reveal the temperature, salinity and dissolved oxygen of sample locations are high at the river mouth, and these are used to determine whether the conditions prevailing could sustain life. The living-dead ratio show that most of the species are dead in nature and it also indicate slow rate sedimentation and it also correlated with sedimentological and geochemical parameters. The CIA plot against Al_2O_3 indicates moderate weathering and moderate climate in the area. Pollution studies have given way to identify morphological abnormalities in the species, but we could not find many effects among the faunal assemblages because of the nature of the sediments found in that area.

Keywords: Benthic Foraminifera, organic matter, major element geochemistry, estuarine environment, southwest coast, India

MAGNETIC FIELD ANOMALY OF THE LONAR CRATER, MAHARASTRA –A PRELIMINARY INSIGHT

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Abstract

This study has the intention to exemplify the rock magnetic properties and produce a magnetic anomaly model of the Lonar crater, Maharashtra. Lonar crater is a Quaternary aged 1.88 km-in-diameter approximately 150 m deep simple crater with a shallow alkaline water

lake in the middle. The meteorite impact origin of the crater is confirmed by the discovery of shocked materials such as shatter cones, maskelynite, and impact classes [1, 2]. Target of the crater is composed of Deccan Trap basalts, which are exposed in the crater walls. Compared to most of the population of meteorite impact craters on Earth, target of Lonar is relatively uniform in its physical properties which makes it a perfect natural laboratory for studying the effect of hypervelocity impact to various physical properties of target rocks, including magnetization.

In 2017, part of the team (J.P., M.L., H.J.S., and M.S.) has produced a total field magnetic map of the 6×6 km area covering the crater and surrounding areas. Recently (2018), magnetic susceptibility (MS) of basalts and lake sediments were measured. Together with earlier published structural and geophysical data [e.g., 3, 4], these serve as a base for geological model of Lonar.

In the magnetic field the Lonar impact is seen by a combination of positive and negative high amplitude anomalies. Amplitudes of the anomalies reach -2,000 and +2,900 nT. High positive values (700 to 2600 nT) are mainly seen along the northern and eastern part of the rim. High negative values (-700 to -2000nT) are mainly observed in the southern and western part of the rim, bottom of the crater and valley in the NE section of the rim.

Four MS profiles are made while ascending or descending NE, E, S, W along the crater wall. NE ascending traverse can be separated into two parts: upper and lower basalts (upper – lower indicate the position relative to the crater wall), with a paleosol layer in between. East descending traverse can be separated into three parts: upper-, middle-, lower basalts. These are separated by paleosol layers. South ascending traverse can be separated into two parts: upper and lower basalts, with a paleosol layer in between. In W ascending traverse no paleosol layer was identified and only basalts are measured. MS values of basalts range from $11,000$ to $67,000 \times 10^{-6}$ SI, 4900 to 9300×10^{-6} SI for paleosols and 800 to 1200×10^{-6} SI for lake sediments.

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MODELING MADDEN JULIAN OSCILLATIONS WITH ANISOTROPIC SCALING OF BETA-PLANE SHALLOW WATER SYSTEM

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Abstract

The Madden Julian Oscillation (MJO) is the large-scale intra-seasonal variability (30-90 days) with in the tropics. It is the dominant tropical atmospheric oscillations with a moist convection of planetary wave like disturbance, propagating eastwards with wavelengths ranging from 10,000 to 40,000 Km, with an average velocity of 4 to 6 m/sec [3]. MJO has an impact on local weather as well as global climate variabilities. MJO poses great challenge in detailed observation and explanation. Several theoretical models were proposed to explain the behaviour of MJO and the most important ones are based on the seminal work of Matsuno (1966) and Gill (1980), which models the tropical atmosphere as a simple shallow water system with an equatorial beta plane approximation [1, 2, 4]. The primary aim of MJO models is to recover the basic features of its dynamics, the most representative one is its peculiar dispersion behaviour $\omega/k \sim 0$. While the study based on simple Matsuno-Gill model could explain some skeletal features of MJO, it faces difficulty in explaining the horizontal quadrupole vortex structure. The modern atmospheric General Circulation Models (GCM's) has been used to study the MJO's role on the interactions across scales and in explaining the planetary response to MJO, but complex models are also failing in simulating and predicting the multi-scale dynamic nature of MJO [5].

For a better understanding of the dynamics and interactions of MJO, an attempt is made to study the dispersion characteristics of MJO by using anisotropic time and length scale factors on the equatorial beta-plane shallow-water model. The anisotropic scale factor introduced is providing a more flexible model, which is useful for simulating detailed MJO dynamics. The present paper summarises and attempts to compare various theories of MJO anchored at shallow-water system and discusses the effect of the introduction of the scale factor on the behaviour of its dispersion.

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FERRIDE GROUP ELEMENTS AND THEIR SIGNIFICANCE IN THE ORIGIN OF BANDED IRON FORMATIONS OF THIRUVANNAMALAI GRANULITIC TERRAIN, TAMIL NADU, INDIA

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Abstract

The ferride group elements (Mn, Ni, Ti, Co, Cr and V) and their significance in the origin of Banded Iron Formations (BIF) of Archaen high grade granulite gneiss belt of Tiruvannamalai area are presented here. About 10 BIF samples were collected and analyzed for the ferride group of elements. The results of geochemical analyses show ferride group elements low concentration in BIF samples than in pyroxene granulites. The proportional of Manganese (Mn) and Titanium (Ti) are enriched compared to other elements. The depleted ferride group elements banded iron formations indicates that the source may have been derived not from volcanic sources and from weathering of landmasses. Also, the FGE correlated with other world iron formations shows their similarities with other well-known meta-sedimentary banded iron formations. The results, suggested that the BIF and associated

pyroxene granulites of Thiruvannamalai regions are different modes of origin namely meta-sedimentary and meta-volcanic respectively.

Keywords: Banded Iron Formations (BIF), Ferride Group Elements (FGE) and Thiruvannamalai region, India.

PICTURING SEPULCHERED METEORITE IMPACT CRATERS USING INTEGRATED GIS AND GEOLOGICAL RECORD

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Abstract

Impact cratering is a dominant surface modification process in the Solar System. The record of impacts on Earth is sparse owing to the active geological processes. Only 190 impact craters were so far confirmed on earth [1]. It is suspected that hundreds to a thousand additional impact craters are still undetected due to their unrecognizable morphology and poor exposure. These craters were either buried or eroded. The Dhala impact crater is such a sepulchered impact crater located in Shivpuri district, Madhya Pradesh, India [2,3,4]. This is considered as a “cauldron structure” by earlier studies, but later proved to be formed by a meteorite impact during Paleoproterozoic. The presence of a mesa like structure located at the center of the crater, contemplated as ‘Central Elevated Area’ (CEA) of a complex crater, and preponderance of brecciated granite prompted to call it as a complex crater. Rather it is a remnant of denudational processes that acted on the Proterozoic Vindhyan sediments in the crater. The present study, using an integrated GIS and geological records, proved that the Dhala crater is a simple crater having a diameter of ~3km [5].

Keywords: Dhala Impact Crater, Simple Crater, Complex Crater, Central Elevated Area (CEA), GIS, Sepulchered impact crater.

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MICROPALEONTOLOGICAL STUDIES AND ITS ENVIRONMENTAL IMPLICATION IN YEDAYANTHITU KALIVELI, KADAPPAKAM, TAMIL NADU

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Abstract

The current study intention is to understand the distribution of benthic foraminifera and its environmental situations of the core sediments retrieved from the estuary region of Yedayanthitu Kaliveli, Kadappakam along the east coast of India. The ecological parameters such as sand-silt-clay, calcium carbonate, organic matter and trace elemental studies were prepared to study this estuary environment. Sample were collected using a core catcher (Piston corer). The core was having a length of 90 cm and was sub-sampled at an interval of 5cm. Thus, a total no of 18 samples were achieved and they are subjected to standard micropaleontological and sedimentological analysis for the evaluation of different sediment characteristics. The commonly utilised classification proposed by Loeblich and Tappan (1987) is used for the identification of foraminifera in the current study.

Calcium carbonate percentage was determined by the titration method (Piper, 1947), organic matter (Jackson 1958), Sand-Silt-Clay (Krumbein and Pettijohn 1938). The geochemical studies for total Fe, Mn, Cr, Cu, Ni, Co, Pb and Zn were conceded using a Perkin Elmer AA 700 AAS equipped with a deuterium background.

26 foraminifera taxa belonging to 18 genera, 12 family, 8 superfamily, and 4 suborders have been recognized. Of which, the genus *Ammonia*, and *Elphidium* dominates the total

assemblages followed by *Quinqueloculina*. Outstandingly *Ammobaculites subcatenulatus*, *Cycoforina contorta*, and *Quinqueloculina pygmaea* are testified first time in this region.

Based on the sand-silt-clay ratio it is witnessed that the core sediments in the study area are dominated with medium and fine sand. The Organic matter percentage ranges from 0.5 to 6%. CaCO_3 percentage ranges from 6.23 to 7.37%. The top and middle core obtains more organic matter content than the bottom core which shows the mixing of recent sediments of top surface may favour for enrichment of foraminifera due to tidal action, a greater number of dead shells drifted and deposited in this region. Compare to the top and middle of the TFN and organic matter is slighter in amount. Fast reduction in faunal frequency and diversity may be due to diagenetic processes.

Based on the grain size studies, the top of the core is moderately sorted to moderately well sorted in nature (0.70 phi to 0.657 phi) whereas, the remaining core middle to bottom received moderately well sorted in nature. Due to high energy conditions it shows moderately well sorted in nature. Moderately well sorted with medium and fines indicates the depositional environments in this area.

Based on the trace element studies it is observed that Fe and Cr is more predominant in this region may be due to terrestrial input. The remaining trace element concentration in this region may be due to anthropogenic input.

It is observed that silty sand and sandy silt are more accommodative substrate for the population of foraminifera. Further, based on the foraminiferal studies it showed that the top core, upto 30cm is mixing environment. The middle core indicates the reducing environment and bottom core reflecting the diagenetic environment.

LITHOLOGICAL DISCRIMINATION OF ULTRAMAFIC AND MAFIC COMPLEX OF METTUPALAYAM USING ASTER DATA.

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Abstract

Mafic and ultramafic rocks are considered as the repository of economically valuable minerals. Southern Indian continental crust has witnessed several episodes of mafic and ultramafic magmatism. Among which, the mafic and ultramafic rocks of Mettupalayam belongs to the Archean Bhavani complexes, forms an important complex in southern India. The present contribution attempts to understand the spectral signatures of mafic and ultramafic rock groups such as pyroxenite, gabbro, meta-gabbro and peridotite rocks of Mettupalayam. The samples collected from the different locations of Mettupalayam were taken for the mineralogical and geochemical analysis (XRF). The CIPW Norm classification were derived by using geochemical values. The AFM diagram is derived by using the geochemical data indicated that, the samples are belonging to theolitic series. The Visible Near Infrared (VNIR) and Short-Wave Infrared (SWIR) of ASTER data were used for the image processing techniques such as band combinations of True Color Composite and False Color Composite. The Principal Component analysis, Minimum Noise Fraction and Pixel Purity Index were derived to enhance the lithological discrimination of Mettupalayam area. Lab spectra of rock samples show the Fe²⁺ absorption at 600nm, CPx absorptions at 1013nm and 1950nm, OH absorption at 1446nm, Fe³⁺ absorption at 1660nm, Mg-OH absorption at 2250nm. The lab spectra were resampled to ASTER wavelength show the Fe²⁺ absorptions at 625nm and 1900nm, FeO absorption at 1150nm, OH absorption at 1400nm, Fe³⁺ absorptions at 800nm and 1600nm, Al-OH absorption at 2150nm and Mg-OH absorption at 2300nm. The image processing outputs such as various band combinations of True Color Composite (Band 1, 2, 3), False Color Composite (Band 3, 2, 1), Principal Component Analysis (Band 3, 2, 1) and Minimum Noise Fraction (Band 1, 2, 3) are enhanced the mafic and ultramafic lithologies in the Mettupalayam region. The ASD laboratory spectral signature

were characterized and validated with geochemical data. The absorption features of laboratory spectra, spectra from ASTER data and resampled spectra were correlated well.

ANALYTICAL EVIDENCE FOR SUBSURFACE WARMING TREND IN TROPICAL INDIAN OCEAN

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Abstract

The present climate change has a warming impact on the atmosphere and oceans, hence called as global warming. Study about oceans is relevant to the current scenario of changing climate and many studies show significant warming trends in the Sea Surface Temperature (SST) in the ocean during the past several decades. Warming signals are now found at deeper oceans too. In this study, the annual mean subsurface temperature data which was spatially averaged over the tropical Indian Ocean (IO) during the period 1950 to 2012 was subjected to a statistical EMD analysis to estimate the impact of warming to deeper IO. The temperature signal is decomposed into components called as Intrinsic Mode Functions (IMFs) along with a residual part. The IMFs represent the temperature fluctuations resulting from inter-annual oscillations such as ENSO (El-Nino Southern Oscillation) as well as Quasi-Biennial Oscillations (QBO), and the residual part can be considered as the long-term trend. The IMFs obtained at each depth showed variabilities at QBO, ENSO and tidal frequencies. Residual part of the signal too had significant magnitudes, indicating the impact of global warming signals at deeper oceans. Significance of these warming trends during the drought/flood years has also been studied.

TRACE ELEMENT SIGNATURES IN PYRITE AND PYRRHOTITE IN THE PEGMATITES ASSOCIATED WITH A-TYPE GRANITES OF MADURAI BLOCK, SOUTHERN INDIA.

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Abstract

The Nagamalai- Pudukottai area of Madurai Block, Tamil Nadu forms part of the Southern Granulite Terrain. The A-type granites and associated pegmatites of this area are emplaced along the NW-SE trending Vaigai lineament [1]. The gray and pink varieties of pegmatites of this area can be categorized as simple and homogenous types. These pegmatites contain miarolitic cavities which host quartz, feldspar, calcite, and a variety of euhedral sulphide minerals. Pyrite, pyrrhotite, chalcopyrite, bornite, and molybdenite are the main sulphides identified. Pyrrhotites associated with the granitic pegmatites are magnetic and hence are monoclinic pyrrhotites. The monoclinic pyrrhotite-pyrite association points to their low temperature of formation [2]. The SEM-EDS and ICP-OES analysis of pyrite and pyrrhotite reveal the presence of Ba, Cd, Co, Cr, Mn, Ni, Pb and Ag. The very poor concentration of Co and Ni in pyrite and pyrrhotite also indicate their origin under very low temperature. Copper is present in appreciable amount in these sulphides. Trace element concentrations and the lower temperature of formation of the sulphides suggest their hydrothermal origin. The abundance of chalcophile elements in the sulphides indicates that the aqueous fluid saturation has occurred before the magmatic sulphide saturation.

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ETHIOPIAN RAINFALL $\delta^{18}\text{O}$: A TOOL TO RECONSTRUCT COHERENT VARIABILITY OF INDIAN SUMMER MONSOON AND SAHEL RAINFALL

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Abstract

Boreal summer monsoon (June to September, JJAS) rain is the main fresh water source for the Sahel region and the Indian subcontinent. Failures in the monsoonal rain, droughts, have a big societal and economical consequences in these regions and therefore the mechanism of such droughts has been an important topic of scientific research. Here we identify a common mode of interannual JJAS rainfall variability over the Sahel and Indian regions and demonstrate the influence of Pacific sea surface temperatures on such coherent monsoon fluctuations. Principle Component (PC1) of this leading mode of variability (EOF1) correlates well with both Indian summer monsoon and Sahel rainfall. ~ 40-year-long monthly observations of rainfall $\delta^{18}\text{O}$ and δD at Addis Ababa, Ethiopia co-vary well with PC1. We find, ^{18}O depletion in Ethiopian rainfall during the wet phases of PC1 is due to the intrusion of westerly moisture transport from the Atlantic to Addis Ababa. A century-long $\delta^{18}\text{O}$ record of an actively growing speleothem from Ethiopia matches PC1 over decadal timescales. We highlight the potential of rainfall isotopic records from Ethiopia to investigate the natural variability and responses of the Indo-African boreal monsoons.

SALINE WATER INTRUSION IN LOWER CHANDRAGIRI RIVER BASIN, KASARAGOD, KERALA

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Abstract

Chandragiri basin is the major source of domestic and irrigation water for major part of the city regions of Kasaragod district. During the peaks of summer (April and May months), saline water intrusion is a major problem in the river valley aquifers and the Bavikkara reservoir part. During these periods, entire city region is supplied with salinity rich water. This extension of salinity varies from place to place as per the experiences of residents. Water samples were taken from 42 locations by making 10 profiles across the river basin. Turbidity, pH, Electrical conductivity, Acidity, Alkalinity, Total hardness, Calcium, Magnesium, Chloride, Fluoride, Iron, Nitrate, Sulphate, Sodium, Potassium and bi-carbonate were measured in pre-monsoon (May) and post-monsoon (October) seasons. It was observed that saline ingress was very prominent during pre-monsoon season in this area. Observation wells close to river banks showed higher concentration in the parameters than the one which is located away from the bank in the profile taken.

Keywords: Saline water intrusion, Chandragiri, Hydrogeochemistry.

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DEEP SEA OSTRACODS AND MICRO-ENVIRONMENTAL CHARACTERISTICS OF BATHYPELAGIC CORE SEDIMENT, OFF VISAKHAPATNAM, BAY OF BENGAL

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Abstract

Ostracods are Crustacean microorganisms that have adapted to almost all aquatic and some terrestrial habitats [1]. Deep sea Ostracods and their relationship to the variations in the sedimentological characteristics is the prime focus of the present work. Potentially, Ostracod species can yield information on the paleoenvironment of deep ocean [2]. We report two Ostracod taxa namely *Krithesp.* and *Cytherpteron* sp. belonging to suborder Podocopa, order Podocopida, have recovered from the subsurface (core length 33 cm) sediments at a water depth of 2540 metres. Throughout the core, fine grained muddy substrate is noticed, which indicates prevalence of low energy condition in the region. Sample number 9 (depth 24-27cm) shows an abnormal fluctuation of Organic matter and Calcium carbonate in the region. This, along with the occurrence of broken Planktic Foraminifera forms with well-preserved Benthic foraminifers and Ostracods, lights on to a high turbulence in the surface waters during the period of sediment deposition. Element weight percentage has determined using EDS for Mg, Ca, Mn, Fe, Sr and Ba and the results shows that a very different trend in elemental concentration exists between these two species. Ostracod occurrence and distribution denotes that a direct relationship exists between the sediment characteristics, shell microchemistry and the water column depth.

Keywords: Ostracods, Shell chemistry, Sedimentological parameters, Bay of Bengal.

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EXTENT OF AGULHAS LEAKAGE AND INTER-OCEAN EXPORT INTO SOUTH ATLANTIC DURING PLEISTOCENE GLACIAL TERMINATIONS

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Abstract

The inter-ocean surface water export into the South Atlantic and Southern Ocean during the past 1.6 Ma is investigated using the relative abundance of planktonic foraminifera analysed from ODP Hole 1088B and 1090B. The presence of tropical – subtropical Agulhas leakage fauna (*Globigerinoides ruber* + *Globigerinoides sacculifer* + *Globorotalia menardii*) at Hole 1088B throughout the time period suggests the export is prominent through the Western boundary of Indian Ocean, and the existence of Agulhas leakage and subsequent shedding of Agulhas rings and filaments. The results indicates pulse like increase at major glacial terminations (eg: MIS 20, 16, 12, 10 and 8) along with high SST values, while the abundance is largely reduced during glacial periods. This show evidences of Agulhas leakage extending as far as 41°S (Hole 1088B) at major glacial-interglacial transitions throughout the Pleistocene. Meanwhile results from ODP Hole 1090B display negligible (less than 1%) presence of Agulhas leakage fauna towards the southern edge of Sub Tropical Front (~41°S). This along with the SST values from Site 1090 indicates the extinction of Agulhas leakage before reaching the Sub Antarctic zone. The Sub Antarctic zone is marked by low SST values and high abundance of Sub-Polar species *Neogloboquadrina pachyderma* (s) (~80% at glacial intervals) throughout the 1.6 Ma. The drastic temperature decline at STF along with cold and dense Sub Polar water acts as a barrier for Agulhas leakage to influence the surface water properties of Southern Ocean.

Keywords: *Agulhas leakage, Southern Ocean, Sub Tropical Front, Agulhas leakage fauna.*

EVALUATION OF TRACE ELEMENT CONCENTRATION IN THE SHALLOW AQUIFERS AROUND THE VEMBANAD LAKE AND ITS SUITABILITY FOR DRINKING PURPOSE

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Abstract

The groundwater is one of the important natural resource, which has a significant role in agricultural, industrial, domestic, and other recreational sectors throughout the world. The depletion of groundwater quality through extensive consumption and less recharge is the major issue in the world water scenario. The present study focuses the region around the Vembanad Lake of Kerala. The study analyses the physico-chemical parameters and the concentration of trace element (Fe, Cu, Ni, Zn, Mn, Cd, Pb, Cr) in the shallow aquifers around the Vembanad lake. In order to define the spatial variability and the quality of groundwater around the lake, 78 shallow open well samples were collected during the premonsoon period of 2018. The physico-chemical parameters were measured *in situ* with a multi parameter water quality meter and the trace elements were analysed using Inductively Coupled Plasma- Mass Spectroscopy (ICPMS). The result reveals that the mean concentrations of Fe, Cu, Ni, Zn, Mn, Cd, Pb and Cr were 269.03, 5.81, 4.85, 110.37, 48.49, 13.25, 31.58 and 0.66 ppb respectively. The increasing trend of trace element concentration shows the following order Cr < Ni < Cu < Cd < Pb < Mn < Zn < Fe. However, the result reveals that the groundwater is slightly alkaline and fresh to brackish in nature. These parameters were compared with the drinking water quality standards prescribed by Bureau of Indian Standards (BIS, 2004). The GIS mapping technique is used to plot the spatial distribution of physico-chemical as well as the trace element concentration in the study area. The Canadian Council of Ministers of the Environment Water Quality Index (CCMEWQI) is a useful and efficient method for assessing the quality of water [1]. Based on this CCME classification, 3.36% of samples fall under excellent category, 29.41% fall under good category, 35.29% fall under fair category, 25.21% under marginal category and 6.72% fall under poor water quality category.

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METAMORPHISM AND PLATE TECTONIC IMPLICATIONS OF THE BANDED IRON FORMATIONS OF THE NILGIRI BLOCK WITH IN KERALA WITH SPECIAL REFERENCE TO THEIR ENVIRONMENT OF FORMATION

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Abstract

The Nilgiri Block lies to the south of the Coorg Block, and is dominantly composed of charnockites and their variants, together with metagabbros, TTG gneisses and BIF. The Moyar-Bhavani shear zone (MBSZ) defines the northern and eastern limits of the Nilgiri Block. On the eastern side of the study area, the Moyar and Bhavani joins together at the east of Nilgiri and to the south of the Salem block, then extends further east as the Salem-Attur shear zone. The banded iron formations of the study area, associated with plunging synforms and antiforms, occur at Cherupa, Eliyottimala, Nanminda, Naduvallur, Alampara, Kakkayam, East and West Hills. Extensive magmatism along convergent margin settings marks the late Neoarchean tectonics in the northern segment of the Southern Granulite Terrane (SGT) in Peninsular India. Here investigates a suite of magmatic rocks (TTG, charnockite and amphibolite) together with accreted banded iron formation (BIF) from the western margin of the Nilgiri Block. The petrologic features of these rocks, including the presence of gruneritic amphiboles, suggest crystallization from calc-alkaline magmas typical of those derived from slab melting. The focus of the study is the petro-mineralogical characterisation of the iron formations. Rare earth element geochemistry of the iron formation will provide insights into the composition of contemporaneous seawater and evolution of the atmosphere, hydrosphere and lithosphere system. The age data converge to indicate late Neoarchean magmatism between ca. 2.6 and 2.5 Ga by using zircon grains from TTG,

Charnockite and BIF. The study also aims to illustrate the plate tectonic settings of the iron formations in the light of new proposals on subduction-accretion-collision history at the margins of the Archean cratons in southern India, thereby revealing the mechanism of formation of the iron ores and the metamorphic history of the associated lithologies and hence constraining the plate tectonic setup.

Key words: Niligiri, BIF, TTG, SGT.

A COMPARATIVE STUDY OF GLACIO-MARINE LITHOFACIES OF RANGIT GONDWANA BASIN AND TALCHIR GONDWANA BASIN OF INDIA

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Abstract

Lower Gondwana (Permo-Carboniferous) basin sediments of the Peninsular and Extra-peninsular India records the Glacio-marine lithofacies. The present study is an attempt to correlate the lithostratigraphy of Talchir Formation of Talchir Gondwana basin and Rangit Gondwana basin of Sikkim-Darjeeling Himalaya. Both Gondwana basin (Talchir and Rangit) have witnessed the late Paleozoic glaciations and are well preserved in the form of sedimentary facies. The detailed petrographic and microfacies study of alternate sandstone-shale and diamictite reveals the linkage and pattern of paleoenvironment sedimentation between both basins. Matrix-supported pebble and gravel with cemented shaly-silty facies together with rhythmites strongly indicate the glacio-marine depositional environment in both basins. Plots of Sandstone and massive diamictites composition diagram of both basins suggest derivation of the detritus from craton and continental block. Detrital grains like quartz, feldspar, mica, heavy mineral and lithic fragments not only provide the lithology of the provenance but also about its tectonic setting. Further Clay mineralogy of shale-mudstone facies has been investigated by X-ray diffraction analysis to understand the paleoclimatic condition of both basins. The presence of Illite and Kaolinite suggest their source of derivation from crystalline rocks containing feldspar and mica.

Keyword: Glacio-marine, Lithofacies, Talchir Gondwana basin, Rangit Gondwana basin, X-ray diffraction, Paleoenviornment .

KIMBERLITE INDICATOR MINERALS IN KANAGANAPALLI CATCHMENT AT GRANITE- GREENSTONE CONTACT WITHIN THE WAJRAKARUR KIMBERLITE FIELD, EASTERN DHARWAR CRATON

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Abstract

This paper addresses, hitherto unreported, occurrence of kimberlite indicator minerals (KIMs) in the northerly flowing 3rd order streams at Kanaganapalli (772255E 1598720N), 30 km south of Anantapur town, Andhra Pradesh forming a part of the Eastern Dharwar Craton (EDC). The catchment is selected based on two factors, (a) one of the Chigicherla pipe, discovered by the Geological Survey of India exists at a distance of 6 km towards north and (b) the area forms contact zone of granite- greenstone with crisscross lineaments. The terrain forms pediment- inselberg complex with good to excellent quality trap sites such as pot holes, boulder traps, vegetation roots and dyke barriers where heavy minerals (HM) accumulate. General lithology comprises Archaean granitoid rocks intruded with dolerite dykes and Proterozoic greenstones of Ramagiri- Penakacherla Schist Belt. At places, the granitoids exhibit gneissosity, multiple sets of joints, intense quartz-alkali feldspar-epidote veins and intersecting lineaments of different orientations. The general strike of steep easterly dipping greenstones varies from N-S to NNE-SSW to NE-SW with crude foliations. The sample sites comprise abundant friable to hard nodular calcrete perhaps derived after weathering of country rocks of fluvial origin. In total, five stream sediment samples, each weighing ~20 Kg, have been collected at an interval of 1 km, along the two streams each extending for ~7 km length. By removing the top alluvium (1-2 feet), the palaeo-gravel has been sampled and HM concentrate (HMC) was collected following standard procedures using manual jig, bromoform

and magnetic separation. The -1 mm HMC fraction was used for microscopic examination to pick various indicator minerals such as chromite, garnet, ilmenite, orthopyroxene (bronzite), sphene, spinels and many mafic prismatic mineral grains which could be different types of pyroxenes and amphiboles. The other heavy minerals include zircon, rutile, cassiterite, magnetite, epidote which could have been liberated from crustal granitoid and greenstone rocks. In the HMC, the grain populations in the order of abundance are ilmenite, chromite, pyroxenes, garnet and spinels. About 170 grains were picked from the HMC and 36 grains were discarded as they appear crustal. Some of the 134 grains, suspected to be mantle derived, were tested for major element compositions by electron probe micro analysis (EPMA). The chromite grains are of kimberlitic in character with one grain plotting in the diamond inclusion field indicating possible diamondiferous kimberlitic provenance. The grossularite garnets are few, plot in the harzburgitic zone (diamond field) and are of G10 variety. The ilmenite grains are of non-kimberlitic nature showing poor to no diamond preservation. The orthopyroxene grains (enstatite/bronzite) are megacrystic and of non-kimberlitic character. Owing to the presence of kimberlite indicator minerals, this study brings out a prospective catchment, spreading over ~30 Sq.Km., forming a plausible target for conducting high resolution geological mapping, additional KIMs sampling and surface geochemical studies which are planned upon obtaining positive results from micro-probing.

Keywords: kimberlite, diamond exploration, stream sediment, indicator mineral survey, KIM, Kanaganapapalli, EDC.

TRACE ELEMENTS CONCENTRATION AND ENVIRONMENTAL RISK ASSESSMENT OF KAYALPATTINAM TO MANAPAD SEDIMENTS, GULF OF MANNAR, TAMIL NADU, INDIA

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Abstract

The present study was carried out to find the trace element concentration and risk assessment in surface sediments from Kayalpattinam to Manapad, southeast coast of Tamil Nadu, India. Twenty-five surface samples were collected from the beach environment to decipher the interrelationship between different parameters such as textural characteristic, calcium carbonate, organic matter and trace elements. The distribution of calcium carbonate in the sediments is controlled by shell fragments whereas the Organic matter content are chiefly derived from riverine input. The distribution of trace elements and Fe, Mn are controlled by the riverine input and geogenic process. Enrichment Factor reveals that the sediments are contaminated by Pb and Ni which falls under no enrichment to moderate enrichment category. Geoaccumulation index, Contamination factor and Pollution load index indicate low to moderate contamination of sediments. The sediment pollution index highlights that the majority of the sediments are low to moderately polluted sediments. The ecological risk indicates that the sediments are under low risk to moderate risk category. The correlation matrix showed that the elemental supply was chiefly controlled by riverine input as well as anthropogenic source in the coastal environment.

RECONSTRUCTION OF EASTERN ARABIAN SEA THERMOCLINE HYDROGRAPHY USING PAIRED MEASUREMENT OF PLANKTONIC FORAMINIFERAL MG/CA AND OXYGEN ISOTOPE RATIOS.

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Abstract

In the Eastern Arabian Sea, paleostudies are largely based on temperature and salinity reconstructions of the Surface /Mixed layer, whereas variability in thermocline in response to global climate change is rarely studied. We present the last 32,000 years record of thermocline temperature and salinity variability derived from the paired measurement of Mg/Ca and Oxygen isotope ratios of a thermocline dwelling planktic foraminifera, *Globorotalia tumida* using a core from Eastern Arabian Sea. Our record suggests that the thermocline was 5°C colder during the last glacial when compared to Holocene whereas the salinity was higher by 1psu between 24 ka-19 ka and rapid a decrease in salinity by 2 psu was recorded at ~15 ka. The higher salinity during the LGM is a result of sinking of high salinity (denser) water from the mixed layer to the thermocline. The increased influx of low salinity SAMW-AAIW might have resulted in the observed salinity decrease at ~15 ka. Thus the changes in the physical properties of thermocline is a combined effect of variation in the supply of remotely sourced intermediate water mass and the seasonally reversing monsoon winds.

DELINEATION OF PALAEOCHANNELS IN PARTS OF SON RIVER BASIN, BIHAR USING REMOTE SENSING AND GIS

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Abstract

The old courses of river channel or palaeochannel have become a fascinating topic in present scientific studies as it not only provides signatures of groundwater sources and probable presence of economic resources but also proves as a tool for disaster management. Palaeochannels have been dealt since long by different methods both conventional and unconventional but the latter one which includes the application of modern techniques like Remote Sensing (RS) and Geographic Information System (GIS) have proved to be more fruitful. Using various parameters like moisture content (NDWI) and vegetation cover (NDVI), palaeochannel delineation can be well established. These indices aided with satellite imagery and some literature sources like archaeological evidences which can be dated back closer to old courses have been employed in outlining palaeochannels of the Son River. Son River has myriad of changed courses during its geological history which have been presented by the application of modern techniques of remote sensing. The present study has a great significance in groundwater studies and can serve as a tool in groundwater exploration and sites for artificial recharge, disaster management (particularly flood control) and also for economic deposits exploration.

Keywords: Delineation, Palaeochannels, NDWI, NDVI, Son River, GIS tools.

IRON OXIDES AND THEIR COLOR ATTRIBUTES OF HIGHLY WEATHERED TROPICAL SOILS IN KERALA

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Abstract

In delineating differences between soils and in describing the characteristics of a soil profile, color is one of the most useful attributes. The color of the soil profile varies depending on the nature of formation and mode of occurrence. The parent rock responsible for the formation has a significant role in the type and colour of formation of soil. Along with that the climatic and environmental factors have a significant control on the physico-chemical properties of soil. A good example from such a situation is the formation of lateritic soil which is restricted to tropical climate. The organic matter and Fe oxides are the most important pigmenting agents for the color of highly weathered soils. The Fe oxides appear mainly as goethite, which is responsible for the yellowish and brownish colors, and hematite, which imparts the red colour. To distinguish and classify soils based on color Munsell colour notation (an internationally accepted classification scheme) is adopted by pedologists all over the world. The method for determining this important soil property is a visual comparison between a given soil sample and the various color chips in an array of artificially produced Munsell colors arranged according to hue, value, and chroma. In this study, an attempt has been made to identify redness rating of soils in the three soil profiles (SPG, SPC, SPS) of different lithology from the three locations in Kasaragod district in Kerala using Munsell colour Notation. The parent rocks are Gneiss, Charnockite and Sandstone. The colour analysis was done in both premonsoon and monsoon samples in order to obtain colour at different moisture condition under daylight. The soils were given a redness rating for their red colour according to the following expression: Redness rating (RR) = $[360 - 5H^0] C/18V$ where C accounts for the chroma, V is the value, and H^0 is the angular hue. The angular hue (H^0) represents Munsell hues and range up to 360° according to its position in the colour circle. It can be calculated using the formula $H^0 = [36 Ip + Is/10]$ where Ip is the numerical coding of Munsell Hue segment (i.e. Hue R $\rightarrow$ 0, YR $\rightarrow$ 1, Y $\rightarrow$ 2, GY $\rightarrow$ 3, G $\rightarrow$ 4, BG $\rightarrow$ 5, B $\rightarrow$ 6, PB $\rightarrow$ 7, P $\rightarrow$

8, and RP → 9), and *I*_s is the number associated with that Hue (i.e. 7.5 for 7.5R; 5 for 5YR, etc). The Munsell chroma was related to the presence of Fe oxides, giving an idea of relative amounts of either hematite or goethite. In the soil profiles of Gneiss, Charnockite and Sandstone, the release of Fe from primary minerals by weathering of relatively unweathered parent materials and its subsequent oxidation has resulted in a net increase in the amount of Fe-oxides with time. A relative increase in hematite over goethite indicates that the environment favors the formation of hematite. This suggests that from the Fe released, relatively more hematite than goethite was formed with time, indicating a pedoclimate favourable to hematite. Environmental conditions and parent material influence weathering rates of iron-bearing minerals and the proportions of the secondary oxides formed. In drier and warmer pedoclimates, with a low content of organic matter and slightly alkaline pH, hematite is favoured over goethite. All the three soil profiles show a high degree of weathering. The soils are characterized by reddish to reddish brown colours, clayey textures and abundant clay coatings. Reddish colour in soils is mainly due to the presence of hematite particles while the yellow colour is determined by the presence of goethite. The red colour in soils is prevalent, even when the amount of hematite is lower than that of goethite. The minimum to maximum value of redness rating of SPG, SPC and SPS are 17.7 to 30, 6.25 to 29.7 and 27 to 40 respectively. The result of the Munsell colour notations and Redness Rating (RR) shows positive values which are indicating the presence of significant amount of hematite. The study has demonstrated that hematite is an extremely effective pigmenting agent; relatively minor quantities being capable of masking other components and imparting reddish hues to soils. Reddish hues in soils may be inherited from the parent material or formed by diagenetic processes (including groundwater oxidation).

PETROGRAPHIC AND GEOCHEMICAL STUDIES OF INCIPIENT CHARNOKITE AND ASSOCIATED ROCKS, SOUTHERN INDIA: IMPLICATIONS FOR CRUSTAL - SCALE DEHYDRATION, MELTING AND HYDRATION

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Abstract

To the southeastern margin of the Trivandrum block, southern India, both large-scale and small-scale orthopyroxene-bearing dehydration zones occur in migmatitic garnetiferous biotite gneiss (GBG) in and around Parakkani area. Interplay between melting, melt segregation, dehydration and hydration is observed. They are characterized by the presence or absence of garnet grains, highly migmatized and are intercalated with bands and lenses of quartzo-feldspathic gneissic/ leucogranitic composition. The highly varying dimensions of these bands indicate the presence of crystallised melt pockets of deep crustal origin. Geochemistry has shown that the GBG and incipient samples are peraluminous to moderately peraluminous while massive charnockite fall in the metaluminous field. Strongly peraluminous magmas are derived from mature pelitic sediments and produce S-type igneous rocks, but here GBG are not so intensely peraluminous, discounting their being categorised as metapelitic. The source rocks are intermediate to felsic igneous rocks as well as products of partial melting of metaluminous mafic material. GBG falls in the WPG field of Nb vs. Y and Rb vs. (Y + Nb) plot. All charnockite, syenite and majority of GBG fall in calc-alkaline field and some GBG in tholeiitic field. From the EPMA analysis it is cleared that almandine is the dominant member followed by pyrope, grossular and spessartine. The transformation of garnet to orthopyroxene in charnockites and vice-versa in gneisses is indicative of pro and retrograde phases of metamorphism in protoliths. The mineral chemistry of garnet gives the idea that the region has experienced a minimum P-T condition of 8.5 kb and 800°C, in the range of granulite facies of metamorphism. Based on the coexisting mineral assemblages in the gneisses, charnockite and associated rocks, it is found that the rocks of

the area have undergone granulite facies metamorphism. Our study shows that these rocks have been originated from purely magmatic sources with metamorphic overprints. The xenoliths of GBG in charnockites demonstrate that some degree of assimilation has taken place during the said mafic charnockite magmatism.

WATER QUALITY ASSESSMENTS IN THE COASTAL LANDS OF CHALAKUDY AND PERIYAR RIVER BASINS, CENTRAL KERALA, INDIA

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Abstract

The anthropogenic activities like urbanization and unprecedented growth of population has imparted marked changes on surface and ground water resources of the world. Studies reveal that many of the urbanized areas in the world are now facing serious ecological problems due to contamination of water resources consequent to unscientific disposal of waste products from industries, townships and sewage channels [1-3]. Maintaining the purity of fresh water resources has now become one of the greatest challenges of the modern world. The availability of good quality drinking water is a critical issue in many parts of the world. Added to these are the problems related to the depletion in the quality and quantity of the fresh water resources due to natural [4,5 & 6] (agricultural, urban and industrial developments) causes. The available quantity of fresh water resources is limited, at the same time, the demand of water is on rise in order to satisfy the needs of the ever-increasing population.

This paper deals with the variation in the water quality of the surface and ground water sources in the two important river basins of central Kerala, the Chalakudy and Periyar. Various anthropogenic activities including agriculture, urbanization and industrialization in river basins impose marked variations in the concentration of hydro-chemical parameters.

Here, we examine the quality of surface and ground water sources in the coastal lowlands of Central Kerala, the prime development centre in the southwest coast of India as a case to highlight a few aspects of the water related problems in an urbanized coastal strip which is prone to climate and sea level changes. The study reveals notable differences in most of the water quality parameters. The pH, DO, BOD, TC and FC register high values in surface water than ground water. The values of conductivity, chloride, nitrate, magnesium, silicate, Fe and TDS are high in ground water. Majority of the parameters are within the prescribed limits of BIS/WHO water quality standards except the values of Total Coliforms (TC) and Fecal Coliforms (FC). The high incidence of bacterial contamination noticed in the water sources stresses the need for proper treatment before human consumption.

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WAVELET ANALYSIS OF MAGNETIC SUSCEPTIBILITY DATA OF LACUSTRINE SEDIMENTS: EVIDENCE FOR LATE HOLOCENE CLIMATIC PERIODICITIES

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Abstract:

In this study, we have performed wavelet analysis on magnetic susceptibility (χ_{if}) data of sediments from Pookot Lake, a small lake in southern India to understand inherent

periodicities in Indian Summer Monsoon (ISM) and its temporal variability. An earlier study [1] revealed periodicities of 469, 209-134, 14.3, 10, 8.5, 8.1 and 7.8 years in the Pookot Lake χ_{if} data. The temporal variations of the significant cyclicities during the past 1200 cal. years B.P. are investigated using the wavelet analysis. Wavelet analysis decomposes a time series into time-frequency space, enabling the determination of both the dominant modes of variability and how those modes varied with time [2]. Wavelet analysis of the original χ_{if} data and Savgol-filtered data indicated the non-stationary nature of the periodicities observed in the Pookot Lake record. The 209-134 year periodicity shown by spectral analysis appeared prominently in the wavelet plot of detrended data. It emerged as a 110-175 year band with the highest wavelet power (peaking at 134 years). The longer periodicities were predominant during ~ 1117-568 cal. years B.P. and had very low power during the latter half (~ 568 cal. years B.P. to the present). However, the prominent 469 year periodicity indicated by the spectral analysis was also seen in the wavelet plot, but with less significance. This periodicity had the highest wavelet power during ~ 1000-714 cal. years B.P. The shorter periodicities (7.8 years, 8.8-8.5 years, 10 years, 11.9-11.5 years, 14.3, 17.1 years and 21.6 years) shown by the spectral analysis clustered around 210 cal. years B.P. to the present and 651-500 cal. years B.P. They had very low power during the intervening period (500-210 cal. years B.P.) corresponding to the Little Ice Age when Total Solar Irradiance and sunspot activity were minimal. Also, the longer periodicities were dominant during the Medieval Warm Period, during which solar activity was higher. Rainfall in the region was relatively low during the Little Ice Age and high during the Medieval Warm Period [1]. Most of these periodicities appear similar to those modulated by the Sun. Wavelet analysis reveals that rainfall in the region was influenced by solar activity and that χ_{if} was able to faithfully document the solar influence. Similar periodicities are also documented in other paleoclimatic records from the region which proved that the χ_{if} record of Pookot Lake sediments was able to capture many global climatic events. The study confirms the findings of spectral analysis and also provides temporal variations of the significant cyclicities during the past 1200 cal. years B.P.

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IDENTIFICATION OF SEDIMENT CELLS AND THEIR CHARACTERISTICS ALONG THIRUVANANTHAPURAM, SOUTH WEST COAST OF INDIA

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Sediment Cell approach, a recent advancement in the arena of ICZM is successful in many of the developed nations in promoting the sustainability of the coast by minimizing the challenge of sea erosion. The present study is an attempt to identify the sediment cells of 75km long coastline of Thiruvananthapuram district of Kerala, South west coast of India using various geomorphic, geologic and oceanographic variables. Six Sediment cells are identified from this study. Discontinuity observed in field measured shoreline change rate for the period 1995-2015 along the coast is clearly validating the boundaries of sediment cells delineated based on physiographic parameters. The shoreline change rate varies from -2.50m/yr to +6.95m/yr with breaks observed in five spots. These five spots coincide the possible sediment cell boundaries delineated based on physiographic indices. Being densely populated, erosion affected and economically backward coastal tract, this study will provide a physiographic framework for developing conservation measures for the management of Thiruvananthapuram coast.

Keywords: Sediment cell, shoreline change rate, geomorphology, Thiruvananthapuram Coast

GEOLOGY AND PETROGRAPHY OF THE MOLYBDENUM DEPOSITS IN HARUR – UTHANGARAI SHEAR ZONE, DHARMAPURI DISTRICT, TAMILNADU, INDIA

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Abstract

The theme is to focus on the Geology and Petrography of Molybdenum deposits in parts of Harur-Uttangarai shear zone, Dharmapuri district. Ore mineral molybdenite associated with gneissic rocks is analysed under ore- microscopy. This study has revealed the nature of the ore mineral and its associated minerals. Feldspathic epidote hornblende gneiss forms the main rock of the area and contains enclaves of the mafic granulites, gabbro. The rocks in this area are subjected to intense shearing, which has paved the way for secondary mineral development. This is evident from the limonitization, sericitization and high epidote content of the rocks. The field mapping encompasses that the quartz reef has been emplaced within Moyar – Bhavani lineament within which is the Harur – Uttangarai shear zone. Petrography analysis reveals the nature, the textural characters of both the host and its associated rocks.

Keywords: Molybdenum, Harur-Uttangarai shear zone, Geology and Petrography.

LINEAMENT AND DYKE MAPPING USING RS AND GIS: AN ATTEMPT FOR HIGHER RESOLUTION

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Abstract

The mapping of linear features on various types of maps or remotely sensed data is one of the keys to understanding groundwater occurrence, especially in areas with igneous and metamorphic rocks of poor primary porosity, commonly referred to as hard rock terrain. Lineaments mapped with remote-sensing data have therefore been the focus for targeting

well sites for many decades, albeit with varying success. Sometimes lineament mapping, regardless of geologic environment, is believed to be the panacea for successful groundwater exploration. Process includes identification of lineaments and analysis of the same using different statistical tools helps in understanding the terrain in fine resolution. Identifying the presence of dyke with its spatial orientation is equally important in groundwater exploration as dyke most of the time acts as barriers against groundwater flow. Here we report the results of different methods used in the lineament and dyke mapping carried out at Lingasugur area of Karnataka state, a hard rock terrain, part of Dharwar craton. ASTER-DEM with a spatial resolution of 27 m × 27 m, Landsat8 OLI layer with 15x15m spatial resolution and ALOS DEM with 12.5x12.5 were used for lineament extraction which resulted in various resolution results. Dyke mapping was carried out with Landsat7 ETM and Landsat8 OLI layer with different band ratio colour composites. It was found that, ALOS DEM and Landsat8 OLI with band ratio colour composite 7/6 6/5 4/2 yields fine resolution results and can be better used for mapping of lineaments and dykes. ArcGIS 10.3, ErdasImagine 2015 and PCA Geometrica softwares were used for the analysis. Changes in the spatial and spectral resolution of the remote sensing data and image processing softwares are adding better results in the extraction and analysis of surface features for various purposes in the field of earth sciences.

Keywords: Lineament, Dyke, GIS

LATE QUATERNARY OXYGEN ISOTOPE RECORD OF MULTIPLE SPECIES OF FORAMINIFERA AND PTEROPODS FROM THE ANDAMAN SEA

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Abstract

The north-eastern Indian Ocean is an important region for reconstructing changes related to monsoon precipitation and river runoff by using stable isotopes of oxygen ($\delta^{18}\text{O}$). The major

rivers of India and Myanmar are primarily fed by summer monsoon precipitation and responsible for delivering the majority of sediments to the Bengal Fan and the Andaman Sea. Oxygen isotopes of the surface (*Globigerinoides ruber*, *Globigerinoides sacculifer*), thermocline (*Pulleniatina obliquiloculata*, *Neogloboquadrina dutertrei*), bottom dwelling foraminifera (*Cibicidoides wuellerstorfi*) and mesopelagic euthecosomata pteropods (*Limacina inflata*) were analyzed from well-dated Andaman Sea cores. The downcore variations of $\delta^{18}\text{O}$ of the multiple species living in the different water column depth enabled us to reconstruct ice volume effect and changes in the hydrological cycle for the late Quaternary. Combined with temperature estimates and the observed seawater $\delta^{18}\text{O}$ -salinity relationship, the mixed layer $\delta^{18}\text{O}$ *ruber* record is used to estimate past changes in the Bay of Bengal salinity structure and sea level. The order of reconstructed last glacial salinity of surface water ranges from 4 psu in the north to below 1 psu in the south than the Holocene. The $\delta^{18}\text{O}$ record of pteropods (*L. inflata*) shows similar trends with that of foraminifera, but their shells were enriched by 1.2‰ relative to planktonic foraminifera. Compared with *G. ruber*, *G. sacculifer*, *P. obliquiloculata* and *N. dutertrei*, *L. inflata* were enriched by 1.9‰, 1.3‰, 0.9‰, and 0.6‰ respectively. The changes in oxygen isotopic differences of the planktic foraminifera between *G. ruber*, *P. obliquiloculata* and *C. wuellerstorfi* reflect rapid millennial-scale changes in stratification and freshening associated with Indian Ocean monsoon for the last 30 ka in the Andaman Sea.

Keywords: Andaman Sea; oxygen isotope; stratification; summer monsoon; late Quaternary

FLOOD INDUCED CHANGES IN THE CHEMICAL CHARACTERISTICS OF SOILS – A CASE STUDY FROM KERALA, INDIA

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Abstract

There are about 217 wetlands in Kerala and it accounts for as much as one fifth of the land areas of the State. The Thrissur Kole wetland which is an integral part of Vembanad – Kole Ramsar Site is a highly productive floodplain of rivers and account for about 40% of the rice production within the State. It lies between 10° 20' and 10° 40' North latitudes and 75° 58' and 76° 11' East longitudes and 0.5 to 1M below MSL. The objective of this study is to examine the impact of the flooding in soils of this wetland ecosystem due to unprecedented rainfall during 2018 monsoon. Combination of heavy rainfall and breaching of check dams and irrigation bunds had crossed the limit of usual river discharge that occur in the normal monsoon time. The soils were collected from selected locations before and after the great flood. The properties such as pH, electrical conductivity and the available forms of nutrient parameters such as nitrogen, phosphorous, Na, K, Ca, Mg and Sulfur were analyzed using standard procedures. It was found that the values of all the parameters showed significant depletion after the great flood. Effective Cation Exchange Capacity of three locations after flooding was found to be lower than 100mol kg⁻¹ and it indicates the fertility depletion. Turbulent flow due to increased discharge had caused extensive leaching of the top argillaceous silty layer and this will badly affect the water retention capacity of the soil and in turn crop productivity.

A MULTIPROXY STUDY ON LIMESTONE OF VAYOOR VILLAGE, KUTCH DISTRICT, GUJARAT - PALEOCLIMATIC AND PALEOECOLOGICAL IMPLICATIONS

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Abstract

In order to study the paleoenvironmental and paleoecology based on foraminifera, geochemistry and petrography studies of the quarry section samples of Kutch (Vayoorvillage), 11 samples were collected. The microfauna were separated from the sediments by using various micropaleontological techniques. The widely utilized classification proposed by Loeblich and Tappan (1987) for Foraminifera, has been followed in the present study. From this study, a total of 21 species of foraminifera belonging to 10 genera were identified. The species of foraminifera recorded are characteristic of shallow, inner shelf and tropical in nature. The collected sediment samples were used for geochemistry studies such as Chemical Residue Test and Trace Element. From the result of CRT test it was concluded that the sample falls under pure limestone category. And Trace element study indicates the paleoenvironment as Sub-Oxic to Oxidic conditions with two samples showing Anoxic condition. Sub-oxic to Oxidic conditions are due to the near surficial exposure and relatively feeble shallower depositional basin. From the petrography study, it is concluded that the environment existed during Eocene is congenial for the growth of larger foraminifera and matrix were inferred as sparry calcite formed by later diagenetic process. From the collective correlation it is concluded that at the time of Eocene numerous numbers of larger foraminifera like Nummulites and Assilina were present which shows the upwelling of ocean current circulation.

MORPHOMETRIC AND TEXTURAL ANALYSIS OF ITHIKARA RIVER BASIN SOUTHERN KERALA

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Abstract

Watershed development and management plans are very important for surface and ground water conservation. To prepare a watershed development plan, it becomes important to know the topography, lithology, erosional status and drainage pattern of the area. Basin morphometry is a means of numerically analysing or mathematically quantifying different aspects of a drainage basin. In the present study, morphometric analysis of the Ithikara drainage basin has been carried using geographical information system (GIS) techniques. The morphometric analysis of the drainage basin and channel network play an important role in understanding the geo-hydrological behavior of drainage basin and expresses the prevailing climate, geology, geomorphology, structural antecedents of the catchment. The drainage basin analysis is important in any hydrological investigation as assessment of groundwater potential, groundwater management, pedology and environmental assessment. Hydrologists and geomorphologists have recognized that certain relations are almost important between runoff characteristics, and geographic and geomorphic characteristics of drainage basin systems. Various important hydrologic phenomena can be correlated with the physiographic characteristics of drainage basins such as size, shape, slope of drainage area, drainage density, size and length of the contributories etc. Geology, relief and climate are the primary determinants of running water systems functioning at the basin scale. Geographical Information System (GIS) techniques are now-a-days in use for assessing various terrain and morphometric parameters of the drainage basins and watersheds, as it provide a flexible environment and an important tool for the manipulation and analysis of spatial information.

Grain size analysis is an essential tool for classifying sedimentary environments. Grain size is the most fundamental property of sediment particles, affecting their entrainment, transport

and deposition. Grain size analysis therefore provides important clues to the sediment provenance, transport history and depositional conditions.

The present study is an attempt to apply some simple tools of GIS and their principles to systematical study and characterize the Morphometry of Ithikkara River Basin by using arcGIS 9.3 platform. The area forming a part of the Kollam district is drained by a network of channels belonging to Ithikkara river basin. Another important aim of the study is the Texture analysis of River Bed Sediment by using Sieve Techniques.

LATE CENOZOIC PTEROPOD ABUNDANCES/PRESERVATION RECORDS FROM THE MALDIVES, EQUATORIAL INDIAN OCEAN

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Abstract

During International Ocean Discovery Program (IODP) Expedition 359, a long continuous carbonate-rich sequence was recovered from inner sea of Maldives. We investigated pteropod proxies (absolute abundance of pteropods, epipelagic to mesopelagic ratio, total fragments, fragmentation ratio, Limacina Dissolution Index, etc.) from sites U 1467 (water depth: 487m) and U 1468 (water depth: 521m) to understand both surface and deep sea paleoceanographic changes in the equatorial Indian Ocean basin and to improve the understanding of factors influencing pteropod preservation on a longer time scale. A total of 14 species of pteropods were identified and documented their downcore variations from 0 to 707.49mbsf (U1467) and from 447.4 to 846.92mbsf (U1468). The species comprise of both epipelagic and mesopelagic forms, with a high dominance of mesopelagic forms. At site U 1467 pteropod shells are showing high abundances/preservation spike upto a depth of 45m corresponding to MIS 5 (~1.12Ma) which is harmonizing with the percent of aragonite in sediments which is being high in the top 50m. Beyond that depth there noticed fragmented pteropod shells upto 1.5Ma followed by a total absence of pteropod shells and fragments which indicate post depositional dissolution or significant remineralization of organic material

which can be defended by decrease in the $[\text{SO}_4]^{2-}$ concentration and alkalinity in the interstitial fluid geochemistry from Site U1467. Presence of dolomite content below 50mbsf also indicates the alteration of aragonite into dolomite. Fragmentation ratio of pteropod shell is found to increase with increasing depth suggesting an increasing dissolution. Analyses of the aragonite preservation (absolute abundance of pteropods, LDX and Fragmentation ratio) reveal that the pteropod exhibit considerable fluctuations in abundance during the MIS1- 5 and display well to moderate preservation index (LDX: 0 to 3). Epipelagic/mesopelagic ratio are moderate upto 32m depth which are signatures of well mixed intermediate water and abrupt peaks noted beyond, which be a sign of water column stratification during MIS 18-22. This is an attempt to study the long-term record of pteropod preservation to assess the paleoceanographic changes in the Equatorial Indian Ocean basin, which has not received serious attention before.

Keywords: Pteropod preservation, Aragonite, Maldives Paleooceanography

COASTAL PLASTIC POPULATION IN BEACH SEDIMENTS DURING PRE AND POST VARDHAH CYCLONE EVENT, CHENNAI METROPOLITAN, SOUTHEAST COAST OF INDIA – A FIRST REPORT AFTER MAJOR HIGH ENERGY EVENT

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Abstract

The marine micro plastic problem is widely recognized as the universal threat to marine ecosystem. Seven beach sediment samples were collected during Vardah cyclone (next day of vardah cyclone) and post Vardah period (after 15 days) from marina beach to assess the impact of Vardah cyclone on microplastic population. The distribution of polyethylene and polystyrene was drastically increased during post Vardah sediments. The anomalous distribution of polystyrene was noticed along the Adyar River mouth. However, the total microplastic population in Vardah sediments was higher than the post Vardah cyclone

sediments. The unusual distribution characteristic on colour, composition and size of microplastics most probably due to transportation of microplastic through cyclone induced stream water runoff and confluence river water into the coast.

Keywords – Micro plastic Fibers; Polyethylene; Polystyrene; Vardah cyclone; Adyar and Coovum River

FORAMINIFERA AND PALYNOLOGY A PROXY FOR PALEOENVIRONMENTAL STUDIES IN PICHAVARAM AND PUNNAKAYAL MANGROVES, TAMILNADU

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Abstract

Two cores were retrieved of lengths 1.11 m and 1.32 m, from Pichavaram (PVM C-1) and Punnakayal (PKYL C-2) mangrove respectively for paleoenvironmental reconstructions. A total of 12 species are identified from the Pichavaram Mangrove and 82 species are identified from Punnakayal Mangrove area. Of the 12 foraminifera species identified from the Pichavaram mangrove region, six species were dominant viz. *Ammonia beccarii*, *Ammonia tepida*, *Ammonia dentata*, *Elphidium advenum*, *Nonionoides elongatum* and *Trochammina inflata*. Of the 82 foraminifera species identified from the Punnakayal Mangrove area, eleven species were dominant viz. *Ammonia beccarii*, *Ammonia dentata*, *Cycloforina semiplicata*, *Elphidium crispum*, *Miliolina circularis*, *Nonion commune*, *Pararotalia nipponica*, *Quinqueloculina lamarckiana*, *Quinqueloculina seminulam*, *Quinqueloculina tropicalis* and *Sigmavirgulina tortuosa*.

The major substrate in PVM C-1 is silt while in PKYL C-2, it is sand. In Pichavaram Total populations of foraminifera are more in silty sand and decrease down the core, where silt is prominent. Compared to PKYLC-2, PVM C-1 has high amount of organic matter due to the thick mangrove vegetation. The low organic matter in PKYL C-2 is due to the resuspension of organic matter to the water column by tidal activity and increase in the grain size of the sediments.

Algal and fungal spores are more in the top portions of both the cores. In the Pichavaram Mangrove forest, 13 species of mangrove plants have been recorded. *Avicennia marina* is the dominant species followed by *Rhizophora* species. The spores/pollen in PVM C-1 indicates a low-energy environment or low rainfall condition. Relative abundance of *Avicennia* pollen was observed in this core, implying a high saline environment and low rainfall condition. Only terrestrial and grass pollens were obtained from the Punnakayal region, implying that the mangroves of this area are of recent origin, and also that there was a shift in coastal geomorphology and depositional environment. Also, the sandy substrate as well as high saline condition does not support the growth of mangrove plants.

The nature of the substrate, temperature and salinity gradient are the main controlling factors for the abundant distribution of foraminifera in both Pichavaram and Punnakayal Mangroves. Based on the above observation, it can be concluded that Pichavaram Mangrove region was predominantly low-energy environment in the past under anoxic condition corroborated by the decrease of foraminifera population towards the bottom of the core. The variation of substrate in the middle of the core implies a high energy input during the period of sediment deposition. The distribution of spores/pollens are also reveals a low rainfall condition corroborated by the abundance of *Avicennia* species in the sub-samples. Punnakayal Mangrove region was predominantly very high energy environment with oxic condition corroborated by the foraminiferal population towards the bottom of the core.

FLUORIDE IN GROUNDWATER OF A HARD ROCK SUB-BASIN OF NORTHERN KARNATAKA – SOURCES AND CONTROLLING GEOCHEMICAL PROCESSES

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Abstract

Consumption of fluoride through groundwater can be both beneficial and harmful to health depending upon factors like its concentration and duration of consumption, amongst others. As in the case of several other hard rock terrains across India, the catchment area of River

Sindhanur sub-basin too is plagued by the problem of excessive fluoride in its groundwaters. This area is arid, frequently drought affected and characterized by contrasts with respect to geology and agricultural practices. Detailed assessment of physico-chemical parameters of groundwaters was taken up with an objective of understanding their hydrogeochemical characterization with emphasis on occurrence of fluoride, its quantification, areal distribution pattern and demarcation of safe- and hazardous zones, identifying its probable sources, and the underlying geochemical processes that might influence fluoride concentration. Results reveal the presence of excessive ($>1.5\text{mg/L}$) fluoride in 51% samples, the range being from 0.34 to 9.59mg/L . Groundwater fluoride concentration varies within and amongst different lithounits, with metavolcanics housing higher proportion of high-fluoride ($>1.5\text{mg/L}$) groundwaters followed by different granitoids. Apatite and fluorite, identified through petrographic examination and thermodynamic modeling respectively are the primary natural sources of fluoride. Other possible natural sources of fluoride identified include biotite, muscovite, hornblende, sphene and actinolite. Few minerals employed in the manufacture of fluoride-containing fertilizers and agricultural sprays, as indicated by thermodynamic modeling, might also be contributing to groundwater-fluoride. In groundwaters with very high fluoride ($>6.0\text{mg/L}$), biotite is the most likely primary source of fluoride as indicated by its near perfect positive correlation with potassium.

DEEP-SEA BENTHIC FORAMINIFERA AS TRACERS OF BOTTOM WATER OXYGEN CONDITION IN THE CASCADIA MARGIN, NE PACIFIC OCEAN

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Abstract

Pleistocene sediments of the Cascadia Margin have been studied based on benthic foraminifera with a view to characterize the bottom water oxygenation condition. Marine core samples from Integrated Ocean Drilling Program (IODP) Hole U1325B were used to delineate

the oxygen concentration of NE Pacific Ocean. The sediments originate from deeper marine basin and terrestrial infiltration together constitutes the sedimentation rate at ~38 cm/ka. The sedimentation rate defines the organic matter accumulation where the average concentration of total organic carbon results at 0.56 wt% in the continental slope of Cascadia Margin. The epifaunal and infaunal benthic foraminiferal evidence indicates the cumulative strength of species assemblages ranging from ~1200 ka. Eleven epifaunal taxa and fourteen infaunal taxa were identified from the Hole U1325B for the present study. *Cibicides*, *Epistominella* and *Gavelinopsis* were highly dominant in the epifaunal group where *Uvigerina* was reported from the infaunal clutch. Bottom waters were well oxygenated from the seafloor was colonized by oxic, sub-oxic and dysoxic foraminifers. The relative abundance (%) of oxyphilic benthic foraminifers belonging to various taxon i.e. *Bolivina*, *Cassidulina*, *Cibicides*, *Gavelinopsis*, *Gyroidinoides*, *Oridorsalis* and *Quinqueloculina* were chiefly considered to calculate the oxygen concentration ($\mu\text{Mol/Lt}$) in the Cascadia Margin. The reconstructed oxygen record represents the variation of the oxygen contents at the sediment-water interface, and suggest that the actual concentration were ranging from ~ 31 to 1400 $\mu\text{Mol/Lt}$.

Keywords: *Benthic foraminifera*, *Cascadia Margin*, *Bottom water oxygen*, *Pleistocene*.

CHEMISTRY AND MORPHOLOGY OF OLIVINE OCCURRENCES FROM THE OHM CRATER ON THE FAR SIDE MOON: INSIGHT INTO THEIR ORIGIN

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Abstract

Olivine occurrences have been reported from many lunar impact basins [1, 2] and craters. The source of such olivine-bearing lithologies was interpreted to be uplifted mantle lithologies from deep beneath the crust as a result of impact induced isostatic rebound. Further, olivine associated with impact melt deposits were also identified from lunar impact craters [3]. The

clues for the impact melt origin of the olivine in such craters have contradicted the consensus of a primary igneous origin as has been interpreted earlier. The chemical composition and morphology of the surface olivine exposures on Moon will provide clues about their origin and transportation mechanism. Present study addresses the formation mechanism of olivine occurrences in diverse morphological settings within the Ohm crater on the farside of the Moon using orbital remote sensing data. Ohm crater (18.4°N, 113.5°W) is a Copernican aged complex impact crater located on the anorthositic highlands on the farside of the Moon. The crater displays an asymmetric topography with an average diameter of ~64km. Moon Mineralogy Mapper (M³) data from ISRO's Chandrayaan-1 mission has been used for identifying the olivine-rich sites in the Ohm crater. The diverse morphologies displaying olivine signatures have been studied using high resolution Terrain Mapping Camera (TMC of Chandrayaan-I) and Lunar Reconnaissance Orbiter Camera (LROC of NASA) images. Preliminary mineralogical mapping of the crater has been done based on the Integrated Band depth (IBD) at 1µm and 2µm. The crater exhibits extensive impact melt cover which appears to have been draped over the intact lithologies. The central peak of the crater has also been covered with impact melt sheet. Boulder clusters have been found on the gentle slopes of the central peak, thought to have been eroded out of the peak lithounits. Olivine identification is based on the diagnostic overlapping absorption bands centered at 0.85µm (M1-1), 1.049µm (M1-2), and 1.25µm (M1-3) in the VIS-NIR reflectance spectra obtained from the crater. Multiple occurrences of olivine have been detected from various morphological forms in the Ohm crater. Olivine has been identified from the central peak, terraced wall on all the sides as well as megaclasts on the crater floor. The albedo in the olivine-bearing regions varies from 0.01-0.07. Observable albedo differences are apparent among different olivine sites in the crater. Exposures on the eastern wall and SW wall show lower albedo values (0.01-0.03) while the wall exposures on all the other sides exhibit the high albedo surfaces (0.04-0.07). The central peak and megaclasts exposures show intermediate albedo (0.02-0.04). The composition of the olivine associated with different morphological forms has been determined based on the band center of central M2 band in the olivine dominant reflectance spectra. Wall exposures show M2 band centers between 1020nm-1062nm. Olivine on the eastern and northeastern wall has M2 band centers in 1068-1069nm range. Central peak

exposures have band center at 1049nm. Olivine from the clasts on the crater floor shows M2 band center at 1069nm. Typically, M2 band center varies between 1.048 μ m-1.098 μ m in the case of pure olivine. The shifting of the band centers shortward 1.048 μ m is attributable to the mixing with pyroxene or metallic phases. The fayalite content in the wall exposures ranges from Fa₁-Fa₃₃. Eastern and NE wall exposures have fayalite content in the Fa₃₄-Fa₆₄ range. Olivine from the clast on the crater floor also has similar composition as eastern wall exposure. Olivine spectra from the central peak have fayalite content less than 33%. It is evident from the above results that the compositional variations exist among olivine in eastern wall and other regions. We will discuss the possible origin of olivine exposures in relation to specific morphological settings.

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GEOCHEMICAL APPRAISAL OF SEDIMENTS FROM RIVER CAUVERY, TAMIL NADU: AN INSIGHT INTO ITS SEDIMENT MATURITY, PROVENANCE, AND TECTONIC SETTING

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Abstract

This present study describes the bulk sediment geochemistry of fluvial sediments of Cauvery river of Tamil-nadu part with the aim of understanding their, weathering, tectonic setting and provenance. Exposed lithologies in the basin are highly varied, including Granatoids, Gneissic-rocks, Gabbro, ancient supra-crustal rocks including meta-sedimentary and carbonate bands, Charnockites and in downstream it traverses granulite, quaternary alluvium, and cretaceous sediments. The

enrichment of major oxide concentration occur in the following order of abundance: $\text{Na}_2\text{O} > \text{K}_2\text{O} > \text{MgO} > \text{TiO}_2 > \text{P}_2\text{O}_5 > \text{MnO}$. Elevated concentration of Fe_2O_3 , indicates the sediments were derived from the rock due to oxidation, leaching and hydration processes involved during weathering. The weak correlation between Na_2O against $\text{SiO}_2/\text{Al}_2\text{O}_3$ denotes the abundance of plagioclase feldspar in sands. ICV value for sediments of river Cauvery vary between 0.77-1.84 (Mean 1.12) indicates the ascendancy of rock forming minerals. For the bed load sediments of river Cauvery, CIA values reflect the low to moderate degree of weathering in the source region. Discriminant diagram for bed-load sediments reflects the matured continental source area (granitic-gneissic provenance) similar to sediments derived from passive margin.

Keywords: Sediment geochemistry, Provenance, Weathering, Cauvery

POSTER PRESENTATIONS

FIELD CHARACTER, PETROGRAPHY AND PETROGENESIS OF PAN-AFRICAN GRANITES IN COIMBATORE AND ERODE DISTRICTS OF TAMIL NADU, INDIA

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Abstract

A number of Pan-African granites are exposed in Northern Granulite Belt of central Tamil Nadu. These granite bodies run parallel to Moyar-Bhavani-Attur shear zone and intrude into hornblende biotite gneiss, charnockite and older basic / ultramafic rocks. Three types of granites have been demarcated viz., medium to coarse-grained granite, medium grained leuco-granite and pegmatoidal granite. Megascopically, these granites show almost similar character. It is emplaced as different stock for about 150 km in linear fashion from east to west. Their size varies from a few hundred metres to few kilometres in length and 5m to 250m in width. They are massive to weakly foliated. It exhibits compositional variation viz., alkali-feldspar granite, syeno-granite, monzo-granite and grano-diorite. These are medium to coarse-grained, equigranular, leucocratic and essentially made up of quartz (40%), alkali feldspar (25–40%), plagioclase feldspar (10–40%) and biotite. Apatite, zircon and tourmaline are the accessory minerals. Quartz crystals show anhedral nature. Plagioclase is mostly sub-hedral (oligoclase-andesine). The alkali-feldspar represented by orthoclase and microcline. Chemically, these are calc-alkaline in nature, peraluminous to metaluminous and exhibit higher SiO₂ and total alkali. The Chondrite normalised REE pattern indicates enrichment of LREE. The geochemical attributes are comparable with S-type granites. The mechanism of emplacement of this granite is mostly passive type and is post-kinematic in nature. Most of the granites were generated by partial melting of older continental crust between 450 – 510 Ma. Significant crustal component was involved in the generation of these granites as indicated by high initial Sr ratio (0.71214).

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ASSESSMENT OF GROUNDWATER QUALITY IN LOWER PONNAIYAR WATERSHED, KRISHNAGIRI DISTRICT, TAMILNADU, INDIA.

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Abstract

This study was made to find the ground water quality for samples from lower ponnaiyar watershed, Krishnagiri district. The study was carried out to evaluate the factors controlling water composition, major ion chemistry and suitability of water for both drinking and irrigation purposes. Totally, 35 selected locations were taken to evaluate the groundwater quality and its suitability for drinking and irrigation. This study is focused on the determination of physico-chemical parameters such as pH, EC, TDS, Ca, Mg, TH, Na, K, HCO₃, SO₄ and Cl. Groundwater suitability for drinking and agricultural purposes is examined with BIS standards. Cluster analysis is supporting for the grouping on the basis of contamination characteristics of groundwater quality. The analytical results based on TDS values show that 78% of waters fall under fresh category. Na %, SAR, RSC, KR and Wilcox indicate that the water in the study area can be used for irrigation with improved drainage facilities. Piper plot shows the general order of dominance of cations in the groundwater of the study area is Na>Ca>Mg>K and anions is HCO₃>Cl> SO₄. The DWQI maps revealed the future risk zones of the study area. High total hardness and TDS in few places identified that the ground water is highly deteriorated and unsuitable to drink. This study reveals the appraisal of groundwater quality in hand with spatial maps.

Keyword: Groundwater quality, Piper diagram, Gibb's diagram, DWQI and Cluster analysis

SUBFOSSIL WOOD-BASED VEGETATION AND CLIMATE VARIABILITY DURING THE HOLOCENE FROM THE SOUTHWEST COAST OF INDIA

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Abstract

The preponderance of megafossils i.e. carbonized woods, subfossil logs and peat/bog deposits virtually all along the entire coastal stretch of Kerala provides an opportunity to reconstruct the late Quaternary palaeovegetation and palaeoclimate and understand the forcing factors. Although the discovery of fossil woods dates back at least a century, necessary attention has not been paid towards identifying the woods and understanding the vegetational responses to climate fluctuations during the late Quaternary in this region. Considering their ubiquity in the sedimentary sequences, the fossil woods represent a unique palaeoenvironmental database and provide information up to cellular levels. It is also suggested that the carbonized woods, subfossil logs are a valuable source of climate data to alleviate a lack of contemporaneous meteorological records, provided they possess annual growth rings. As 'growth ring formation' is primarily related to climatic conditions, a specimen of this wood can serve as a potential sample for assessing the pattern of climatic changes in the immediate past few thousand years. This technique has gained importance in palaeoclimate study during past few decades, nevertheless such studies are either lacking or are in infancy in the Kerala-Konkan region. Hence, in order to understand the palaeoclimate, it is important to establish the spatial and temporal distribution of the subfossil woods, trace their origin for understanding their climatic affinity by using NLR (Nearest Living Relatives) approach. The study, along with multiproxy climate reconstructions will help in reconstructing the past vegetation and climate and inferring the forcing factors of climate variability.

Our preliminary data from the coastal south Kerala has provided sufficient evidences of subfossil woods in the form of tree trunks representing wet evergreen forests that were deposited/buried under varying sedimentary conditions. The host sediments has varying thickness and composition ranging from clay, silty-clay and even sand sequences. The recovered palaeo assemblages of the subfossil wood logs and partially carbonized wood remains have been dated to the Holocene transgression and advocate for flooding due to heavy rainfall that would have drowned the forest and deposited the logs up to the present shelf. Many of these woods date back to the Late Pleistocene and Holocene and form a valuable source of climate proxy. The palaeoforests manifested by the fossil wood records in conjunction with other proxies depicted warmer environment in this region, which is consistent with a Mid Holocene Thermal Maximum often referred to as Holocene Climate Optimum. Although the preliminary results support a variable climate during the Holocene, detailed studies on sub fossil wood logs and other palaeoclimatic proxies from this tropical evergreen forest region will provide new indices of Asian palaeomonsoon system.

CONTAMINATION OF SURFACE AND GROUND WATER FROM INDUSTRIAL EFFLUENCE: A CASE STUDY FROM DURGAPUR AREA, WEST BENGAL

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Abstract

Water is an essential component required for the survival of living organisms on the Earth. However, with the advent of Industrial Revolution in the 18th century, the technology progressed, but the quality of environment decreased. Water is one of the components which got adversely affected as the waste and unwanted products got disposed into the local water bodies. The study area is Durgapur, situated in Paschim Bardhaman district of West Bengal. It is the most industrialised city in the entire eastern India, with a number of industries like Durgapur Steel Plant (DSP), Shyam Steel Pvt Ltd. Wastewater from these industries disposal sites have been collected in 10 litres bottles. Concentration of elements such as F, Na, Ca,

Mg, Hg, Pb, Zn, Cl, pH, TDS, BOD, COD, P, Si, NH₄, Ni and some elemental content of untreated water were analysed using spectrophotometer and multimeter. Improper treatment of wastewater, which are identified as the main cause of water pollution is affecting both, nearby river Damodar and groundwater bodies.

Key Words: Industrial effluence, water quality

HYDROGEOCHEMICAL CHARACTERIZATION OF CHEYYAR WATERSHED, THIRUVANNAMALAI DISTRICT, TAMILNADU: A STATISTICAL APPROACH

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Abstract

Water is the matrix of life and it is considered as the most valuable natural gift to mankind. So, it is very important to monitor the quality of water that we used for different purposes and it is necessary to take step to protect it. This study was carried out to identify the suitability of groundwater for drinking and irrigation activities and also to find out the factors controlling the geochemistry of groundwater in cheyyar watershed, Thiruvannamalai district, Tamilnadu. Concentration of calcium and potassium are found above the permissible limit in 24% and 26% of the sample, respectively and for other major ions most of the samples are found within permissible limit. For irrigation activity about 75% samples are suitable for irrigation. Wilcox diagram shows more than 70% of samples fell under the good to permissible category. USSL diagram show that almost all samples can be used for irrigation purposes. In magnesium hazard (MH) 80% samples are suitable for irrigation activities. From factor analysis rock water interaction is the main factor that controlling the chemistry of groundwater in the study area. In correlation table TDS, EC, Ca and Mg are correlated to most of the major ions. Two groups of clusters are identified, one contains major ions and another contains TDS and EC. Alkaline earth (Ca+Mg) exceeds alkalies (Na+K) is the major groundwater facies that occur in this

study area and the groundwater present in this area is suitable for drinking and irrigation purposes.

Keywords: Groundwater quality, Factor analysis, Correlation table, Piper diagram, Gibb's diagram, DWQI and Cluster analysis.

MEGA AND MICRO FOSSILS FROM LOWER GONDWANA SEQUENCES OF PENINSULAR AND EXTRA-PENINSULAR, INDIA

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Abstract

The present investigation deals with the mega and micro fossils assemblages recovered from the carbonaceous shale samples, Talchir and Barakar formations, Lower Gondwana sequences of Damodar (West Bokaro Coalfield), Godavari (Prakasham Khani II & IV coalfields), Rajmahal (Rajmahal Coalfield) basins of peninsular and Rangit, Sikkim Himalaya of extra-peninsular, India. The megafossil assemblage is well preserved and represented by pteridophytes and gymnosperms. Pteridophytes comprise Equisetalean axes (order Equisetales), whereas, gymnosperms include species of *Glossopteris* namely *Glossopteris communis*, *G. damudica*, *G. gigas* and *Vertebraria indica* belonging to the order Glossopteridales and *Noeggerathiopsis hislopi* of order Cordaitales. Abundance of *Vertebraria* along with Equisetalean axes in the collection signifies the flushing environmental condition during the deposition of these sediments. Similarly, the microfossil assemblage reveals the dominance of striate bisaccate pollens and sub-dominance of nonstriate bisaccate pollens indicate an Early Permian age. Based on the morphological features of the palynomorphs i.e. striations, non-leathery saccus structure and thin central body it is inferred that the palaeoclimate during the deposition of these sediments was moderately warm with high humidity better suited for the development of the *Glossopteris* flora. The floral assemblage is comparable with the assemblages recovered from other Gondwana basins of

India and therefore, significant to understand the paleoenvironment of peninsular and extra-peninsular Gondwana basins of India.

Keywords: Carbonaceous shale, Gondwana, Peninsular, *Glossopteris*, Extra-peninsular, Paleoenvironment

FLUOROSIS: A CASE STUDY FROM AKKALKOT TALUK, MAHARASTRA

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Abstract

Fluorosis is the most predominant groundwater-related disease prevailed in India. Many Indians have been witnessed and suffering from fluorosis, irrespective of age groups. The prime aim of the research is to analyse the fluorosis impact among the peoples in and around Akkalkot Taluk, Maharashtra and to generate the geospatial distribution map from the affected area. Akkalkot taluk has been monotonously covered by Deccan trap basaltic lava flows, which in turn, covered by thin mantle of soil almost everywhere. The massive and amygdaloidal basalts have been reported with in the sub-strata. Fluoride concentration in Akkalkot Taluk ranges from 1.5 to 3.0 ppm. It was observed that 30 % of the study area were affected by high fluoride content (Shirasi, Sadlapor, Borgav) whereas, 60% of the study area shows normal range of Fluoride concentration as per the BIS, and WHO, standard. The Geospatial map has been prepared and it shows the concentration of fluoride present in Akkalkot Taluk. Fluoride concentration in the study area were varies from 1.5 to 3 ppm. The highest concentration of fluoride has been identified in Sadlapur village i.e. 3 ppm whereas, 1.5 ppm is the lowest concentration were reported. The field research of the fluorosis survey were conducted and it showed that 33.84 % of the population, were affected by gum bleeding, whereas, 32.30% of the population were reported with sensitive teeth. In respect of gum disease and twisted hand, 6.15 % of the villagers were pretentious respectively. In the case of disfigured and mottled teeth, it was found that 7.69 % and 4.61 % of the population

were affected respectively. As far as abnormal limbs concern, 4.61% of the villagers were found pretentious. In general, fluoride formed owing to the weathering and leaching of fluoride bearing minerals from rocks and sediments. There were possibility of fresh volcanic ash enriched in fluoride content and the ash that is interbedded with other sediments, may cause high concentration of fluoride. Fluorosis is a condition caused by intake of too much fluoride while the teeth are being formed. Fluorosis can also cause white or brown discoloration on teeth enamel, or irregularities on the tooth surface. The most serious effect of fluoride is its accumulation in bones from long term excessive exposure, which can lead to skeletal fluorosis and bone fractures.

Keywords: Fluorosis, Fluoride, Akkalkot, Gum bleeding, Sensitive teeth, and Twisted hand.

TEXTURAL AND SCANNING ELECTRON MICROSCOPE STUDIES OF THE TERTIARY SEDIMENTS OF KERALA BASIN, INDIA.

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Abstract

The textural parameters of sand grains from sediments deposited in Northern and Southern part of Kerala were systematically analyzed for reconstruction of the depositional environment. These sands are very fine to coarse, moderately to poorly sorted, strongly negative to strongly positive skewed, and very platykurtic to very leptokurtic., The variations in mean size, sorting, skewness, and kurtosis indicate a change in environmental energy conditions. The environmental interpretations based on various bivariate and multivariate plots of size parameters indicate river and wave transportation of these sandsand deposition in a beach to the riverine environment. The surface textures of these sand grains reveal transportation in a river and wave media and deposition in a littoral to the riverine environment. The subangular to surrounded shapes of these sands indicate less matured and have undergone little transportation mostly through rolling, bottom suspension, and graded suspension.

GROUNDWATER POTENTIAL ZONATION OF KARINGODE WATERSHED, KASARAGOD USING GEOSPATIAL TOOLS

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Abstract

Integration of different data sets together to analyze and understand the influence of each in decision making has become easier in the era of geospatial technology. Here we report an attempt made to identify and demarcate the groundwater potential zones of Karingod watershed, Kasaragod district, Northern Kerala. The Seven thematic layers were considered in this study such as Geology, Geomorphology, Drainage Density, Soil, Slope, Lineament, and Land use and were generated using the survey of India (SOI) toposheet of scale 1:50000 as base map. Land use map was prepared using Hybrid Google Earth imagery. All these themes and their individual features were then assigned weights according to their relative importance in Groundwater occurrence and the corresponding normalized weights obtained based on the Saaty's analytical hierarchy process. It is then integrated with weighted overlay in ArcGIS. Suitable ranks are assigned for each category of these parameters. For the various geomorphic units, weight factors are decided based on their capability to store groundwater. This procedure is repeated for all the other layers and resultant layers are reclassified. The thematic layers were finally integrated using Arc Map in GIS software to yield a groundwater potential zone map of the study area. Thus, five different groundwater potential zones were identified, namely very poor, poor, moderate, good & excellent. Major part of the study area is falling under good to moderate and in coastal region it has shown excellent zone.

Keywords: Karingod water shed, GIS, Analytical Hierarchy Process

HISTORY OF THE INDIAN MONSOON IN THE MID-TO LATE HOLOCENE RECORDED IN THE ANDAMAN SEA SEDIMENTS

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Abstract

The Andaman Sea, the least explored semi-enclosed marginal sea in the northern Indian Ocean appears to be a great repository of paleo-sedimentary archives for climate change. The present study uses two gravity cores collected from the Andaman Sea, and their age controls are based on accelerator mass spectrometry (AMS) dates on mixed planktic foraminifera. The core SSD 18 (lat 12° 28' 19"N long 94° 13'18"E with a depth of 1335 m) and RVS 2 (lat 07° 42'N and long 93° 58'E with a depth of 2301 m) were collected from the Andaman Sea. The core (RVS 2 GC 3) was collected during Indian ridge expedition onboard research vessel Sonne. We used the downcore variation of planktic foraminifera assemblages for unravelling Indian monsoon variability for the mid-to-late Holocene. The relative abundance of planktic foraminifera was analyzed to understand the past monsoonal variability in the Andaman Sea. Five important species in the studied cores are *Globigerinoides ruber*, *Globigerina bulloides*, *Globigerinita glutinata*, *Neogloboquadrina dutertrei* and *Pulleniatina obliquiloculata*. Mixed layer species *G. ruber* is the most abundant species and its abundances reach even 50% at certain depths. The characteristic low abundances of *G. ruber* during Mid-Holocene indicates oligotrophic water was owing to the poor productivity driven by stratification. Upwelling species *G. bulloides* shows low abundances during mid-Holocene. *N. dutertrei*, low saline species showing characteristic changes from mid-Holocene to early Holocene which indicates variations in the fresh water flux and direct precipitation. Overall, the changes in the planktonic foraminiferal species assemblages suggest large variations in river runoff, productivity and water column stratification seen associated with summer monsoon evolution from mid to late Holocene.

Keywords: Andaman Sea, Holocene, Foraminifera, stratification, Productivity, Summer Monsoon

GEOCHEMISTRY AND TECTONIC SETTING OF PALEOPROTEROZOIC ROCKS FROM WANGTU GNEISSIC COMPLEX, LESSER HIMALAYA, INDIA.

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Abstract

A part of Palaeoproterozoic granite gneiss complex, commonly known as Wangtu Gneissic Complex (WGC) is exposed in Wangtu-Karcham-Akpa region along the Sutlej valley, northwest lesser Himalaya, Himachal Pradesh. The core part of this gneissic complex is exposed as the undeformed granitoid body. The basement of WGC is still more or less in its primeval condition. WGC mainly consists of granitoid, granite gneiss, mica schist, and metabasalts. These Proterozoic rocks are striking along the Himalaya and are assumed to be an essential part of the Lesser Himalayan Sequence. Geochemical data reveals that metabasalts have a higher content of SiO₂, K₂O, and low REEs content and also showing the tholeiitic nature. Al₂O₃ / (Na₂O+K₂O+CaO) >1.1, hence most of the WGC granitoid are peraluminous in nature. Bulk-rock geochemistry of granitoids and granite-gneisses from WGC show the calc-alkaline composition. High K₂O/Na₂O (2.21 to 4.5 wt. %) low Ca and Sr, mineral assemblage of (bt-ms-pl-kf±chl±ap) and high Rb, Th, U values relate the Wangtu granitoid to 'S' type. These granitoids indicate the metasedimentary source or have been derived from the preexisting continental crust. Trace element concentration and tectonic discrimination diagram exhibit a collision/volcanic arc tectonic setting. Such type of finding suggests that the lesser Himalayan basement rocks of Paleoproterozoic age are possibly the north Indian continental margin that formed originally as a part of Columbia supercontinent. The Cenozoic constituent of Himalayan mountain belt comprises of different gneissic rocks that form the basement of the Columbia collision belt and are of Proterozoic ages [1]. The tectonic set-up of north Indian continental margin still exist as a matter of debate, although the detrital ages of the zircons within the metasedimentary sequences from the lesser Himalayan rocks are ~3.3-3.1 Ga, 2.7-2.4 Ga, ~1.8-1.4 Ga, ~1 Ga [2] and these ages are

good indicators of the input from North Indian shield are possible provenance for meta-sedimentary units in the study areas.

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COMPARATIVE GEOCHEMICAL APPRAISAL OF FLUORIDE CONTENT IN GROUNDWATER OF BASALTIC AND GRANITIC TERRAIN, KARNATAKA.

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Abstract

Fluorine, an element of halogen group has earned a dubious distinction as “double-edged sword” due to its narrow range of safe limits. This study aims to identify the level of Fluoride contamination in parts of Aland and Yadagir taluk respectively, and also to compare the Fluoride contamination level to identify the lithological implication on Fluoride contamination. 23 groundwater sampling locations were selected randomly around Shahapur taluk and 20 water samples from Aland taluk. In the Granitic Terrain Minimum, Maximum, and average of Fluoride, and pH content is 1mg/l, 3mg/l, 2.0271mg/l and 7.1, 8.2 and 7.469 respectively. In Basaltic Terrain Minimum, Maximum, and Mean of Fluoride, and pH concentration is 0.3mg/l, 3 mg/1.6 mg/l and 7.2, 8.2 and 7.65 respectively. More than 50% of the samples is exhibiting the Fluoride content above the ISO permissible limit. Proper management method should be implemented to improve the quality of the groundwater in these areas.

Keywords: Groundwater, Fluoride, Granite, Basalt (Deccan trap), Kalaburagi (Gulbarga), Yadagir

PETROLOGY OF ULTRAMAFIC – MAFIC BODIES OF MANGALAPURAM – TIMMINAYAKKAMPATTI AREAS, NAMAKKAL DISTRICT, TAMILNADU, INDIA

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Abstract

The present investigation is on ultramafic - mafic intrusives from Mangalapuram – Timminayakkampatti areas, of Namakkal District, Tamilnadu embedded within charnockite and tonalite –gneiss. The country rocks, accommodating the intrusions shows prominent pervasive foliation, and has been extensively distorted to atleast two phases of folding (F1 and F2). The intrusions of the area to be investigated are classified into two types, i.e. metamorphosed ultramafic bodies such as (talc – tremolite - chlorite – biotite schist) and relatively fresh younger peridotite – pyroxenite – gabbroic association. The petrographic analysis of the rocks indicated that mafic variety of the intrusives are melano - mesocratic with coarse to medium grained texture. The older ultramafic varieties are mostly fine grained, some are medium to coarse grained with elongated crystals of needle shaped tremolite-actinolite. The younger intrusive rock is essentially composed of plagioclase, quartz, hypersthene, diopside, chlorite, hedenbergite, hornblende, olivine, biotite and other opaque minerals. The charnockite and tonalitic gneiss consists of plagioclase, quartz, hypersthene, chlorite, hornblende, garnet, epidote and apatite.

Keywords: Southern Granulite Terrain (SGT), Ultramafic – Mafic, Petrographic analysis

SIGNATURES OF SPATIAL VARIABILITY OF RAINFALL IN WATER ISOTOPOLOGUES: OBSERVATIONS FROM SOUTH WESTERN INDIA

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Abstract

Lack of local amount effect (negative relation between rainfall and its heavy isotopic content observed over tropics) in most places of India makes paleoclimatic interpretation of stable isotope-based proxies from India complex. Studies revealed that it is not the local rain amount but the regional or upstream rainfall/ convective activity plays a major role on daily rainfall $\delta^{18}\text{O}$ variability. Here we extensively analyse the isotopic variability of Indian Summer Monsoon (ISM) rainfall of south western peninsular India on multiple time scales (viz., daily, monthly and yearly time scales).

On monthly scale no significant negative relation is observed between ISM rainfall and its $\delta^{18}\text{O}$; showing the independency of $\delta^{18}\text{O}$ on local rain amount. But on daily and yearly time scales, statistically significant negative relations are observed between monsoon rainfall and its $\delta^{18}\text{O}$, where the rain amount explains 4% and 40% of the total variability of rainfall $\delta^{18}\text{O}$ respectively. Besides, low values of ISM rainfall $\delta^{18}\text{O}$ of south western coast of India show significant relation with the upstream convective activity and the associated rainfall over eastern Arabian Sea on all the three time scales. The increased convective activity over the eastern Arabian Sea is characterized by co-occurring of higher rainfall over peninsular India and extending towards the southern Bay of Bengal, while a comparative drier period persists over north eastern India and equatorial Indian Ocean. So our results suggests that, a comparative dry-wet-dry (wet-dry-wet) rainfall pattern is observed over north eastern India, peninsular India and the equatorial Indian Ocean during the occurrence of low (high) values

of rainfall $\delta^{18}\text{O}$ at south western coast of India on all time scales. Thus, the ISM rainfall $\delta^{18}\text{O}$ of south western India captures not only the local or upstream convective activities, but reflects the rainfall pattern of a large domain including the Indian subcontinent and Indian Ocean. In general, the ISM $\delta^{18}\text{O}$ reconstruction from here can reflect the past rainfall variability over a large domain including the Arabian Sea, peninsular India and southern Bay of Bengal. The ^{18}O variations of climatic proxies such as tree rings and speleothems from south western coast of India can be thus better interpreted in terms of these results.

LUMINESCENCE CHRONOLOGY OF FLUVIAL RECORDS FROM LOWER KAVERI AND ITS TRIBUTARY AMRAVATI RIVER IN TAMIL NADU, INDIA.

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Abstract

A flood is a natural event caused by generally extreme precipitation and it leads serious harm to lives and property, scarcity and epidemics. Fluvial deposits such as slack water deposits, oxbow lakes, levee deposits, floodplains are one of the geomorphic archives preserving the signatures of the past climate. In order to predict the floods or to get the recurrence interval beyond historical or instrumental records, a precise chronology is required. Luminescence dating is a 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. Lower Kaveri and its tributary Amravati River make a fluvial system of south-eastern Tamil Nadu. These are ephemeral rivers and get flooded only in the wet season otherwise they remain dry throughout the year. 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 collected samples from recent flood deposits to checking partial bleaching. Most of the samples have shown well bleaching and even the application of various luminescence age models suggested by Bailey and Arnold (2006) have

applied successfully. Here we present the results of OSL dates of samples collected from Lower Kaveri River and its tributary Amravati River, and also provide past flooding records from these rivers. In lower Kaveri River, channel sand is dated to be 2.90 ± 0.20 ka BP overlain by 2 units of past flood deposited in 1.19 ka BP. In the Amravati River section, we are getting OSL ages of 160 years BP to 30 years BP. The records of past 100 to 200 years indicate the drastic changes in climatic conditions associated with recurring tropical cyclonic systems which in turn have resulted in this high frequency in flood event towards the recent time.

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MICRO TEXTURAL STUDIES OF HEAVY MINERALS FROM DEEP COASTAL OF INDIA, ODISHA

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Abstract

The Orissa coast is 480 km long which extends from Balasore in the north to Ganjam in the south. It is not only bestowed with rich bio-diversity but also accounts for 8% of the total coastlines of India. The diverse geomorphologic configuration and nature of sediments found in the coastal plain of Orissa are due to its varied physiographic features and dynamic coastal processes (N.K Mahalik). This coastal plain has been formed from older alluvium as well as newer alluvium of recent origin. The coastal natural systems in Orissa are essentially a prograding and depositional coast, influenced by six major estuaries (Monalisha M and Panda GK, 2008). The Mahanadi, Brahamani and Baitarni rivers have formed large compound delta that define coastal region of Orissa. The coastal area encompasses the Asia's largest brackish water lagoons i.e., the unique Chilka (Dr Janmajey, November 2007) and India's second largest mangrove forest i.e., Bhitarkanika. The Orissa coast, in general

aligns oblique to prevailing winds and waves that generate strong northerly littoral current (RN Mishra & BK Jena). The entire eastern limit consists of a monotonous plain with landforms formed by fluvial, fluvio-marine, aeolian and marine processes. The coastal basin of Orissa are the result of geo tectonic activities, since 100 mya by shearing and drifting of Gondwana land in Cretaceous period (NK Mahalik). The faulting and fissuring which results series of horst and graben manifested in highs and lows of basement concealed under a thick pile of sediments. The long successions of sediments in the coastal graben which results the erosional break and depositional epoch along with marine transgression and regression with fluctuating environment, ie. continental to marine. (T Srinivasa Kumar, 2010). The along shore sand transported in Orissa compares to the highest transport rates in the world, with in the order of 1 million cubic meter of sand transported per year to north of Paradip (Govt of Orissa, 1974). Tidal variation is less than 2 meters and the coastal features are wave dominated in the southern part of the Orissa coast (south of Mahanadi river). As a result, geomorphic features such as Barrier Island, spits, coastal lagoons, beach ridges and swales have formed in this part of the coast (M MMahanty, U S Panda, S Pradhan).

When heavy stable minerals are freed from their matrix by weathering processes, they are slowly washed downslope into streams that quickly remove the lighter matrix. Thus, the heavy minerals will concentrate in stream, beach, and residual gravel and constitute workable ore deposits (Alan M Bateman). The mineral that form placer deposits, have high specific gravity. And are chemically resistant to weathering and which are durable, such minerals include ilmenite, rutile, native copper, chromite, zircon, monazite and various gemstones (Umeshwar Prasad, 2005). There are several varieties of placer deposits, stream or alluvial placer, eluvial placers, beach placers and eolian placers (Hazzan Z Harraz). Heavy mineral placers of beaches and offshore areas of India have been discussed previously by the author Malik, 1974. A number of workers have carried out detailed researches on surface texture and micro features of light minerals (Krinsley and Donahue, 1988; Georgeive and Stoffers, 1980; Cter, 1984). And also certain studies are carried out, based on special, geomorphological, erosional and textural features of southern and eastern coast of Orissa (Pravakar Mishra, P K Mohanty, 1987; Kar P K, P K Mohanty, Panda U.S, 2007; T Srinivasa Kumar, R S Mahendra, ShileshNaik, May 2010). Even though, studies related with Micro textural analysis of heavy

minerals are rare in the eastern coast (V Sunitha, C H Posendra Mohan, 2017). Hence, for this paper an attempt has been made to study petrological significance of placer deposits, in relation with micro textural analysis of samples, to predict sedimental distribution, mode of transportation and deposition.

ESR DATING USING THE Ti CENTRE OF QUARTZ FROM THE LUOCHUAN SITE, CHINESE LOESS PLATEAU: A COMPARISON WITH INDEPENDENT AGE CONTROL

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Abstract

The reliability of quartz electron spin resonance (ESR) dating using the Ti centre was tested through a comparison of the ESR ages of loess from the Luochuan site, Chinese loess plateau, with reference ages. Instead of using an early days protocol like the multiple aliquot additive dose (MAAD) protocol, the single aliquot regenerative dose (SAR) protocol was used to calculate the equivalent dose (De) values of five samples, with expected ages ranging from 28.5 ± 2.9 ka (L1) to 646 ± 65 ka (L6). The ages were then corrected for thermal signal loss, using the lifetime of the Ti centre, $\sim 1.7 \times 10^6$ years, previously calculated for a sample from the same site. The apparent ages range from 59.4 ± 3.8 ka to 517 ± 42 ka and the corrected ages range from 60.4 ± 3.8 ka to 617 ± 50 ka, respectively. For the youngest two samples ages are overestimated compared to the expected ages, which is presumably caused by incomplete signal resetting before burial. The apparent age of the oldest sample shows an age underestimation of $\sim 20\%$, but after thermal signal loss from the Ti centre is corrected for, the age is consistent with the reference age. Both apparent and corrected ages of L3 and L4 are in good agreement with independent age control. We show, that with careful consideration of the thermal stability and bleachability of samples, reliable age calculation using the Ti centre is possible.

UNDERSTANDING THE MINERALOGY OF KOROLEV BASIN

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Abstract

Concepts about lunar mineralogy and composition is undergoing change with increase in technological advancement of the lunar missions. Plagioclase, olivine and pyroxene are the most abundant minerals known on moon, which constitute anorthosite and basalts, the major rock types on Moon. Moon Mineralogy Mapper (M3) on-board Chandrayaan-1 mission has helped in negating the dominant belief of moon being bone-dry by discovering water signatures on its surface. It also played the instrumental role in discovering Mg-Spinel ubiquitously on the lunar surface. M3 has helped in distinguishing various types of basalts in the lunar surface. In this work, we are making an effort understand the mineralogy of the Korolev basin on the far side of the Moon (4.0°S 157.4°W). It is one of the large (diameter = 437 km) multi-ring basin. Due to its large size, nearly 13 of M3 I/F (i.e. apparent reflectance) datasets were mosaicked and processed for mineralogy. Parameters like Integrated Band depth (IBD) at 1000, and 2000nm were derived such that different mineral such as olivine, pyroxene and spinel are highlighted. In IBD colour composite (R:IBD1000 , G:IBD2000 B:1489 nm refl band), most of the Korolev region shows yellow to orange colour indicating basaltic composition amidst a more dominant anorthositic (blue colour) highlands. The green colour at certain location show deep absorption at 2000 nm indicator of presence of spinel. A further study of the reflectance spectra over the region also suggest presence of spinel, but mostly, in association with pyroxene, which needs more explanation. Since most of these spinel occurrences are associated with small impact craters and their ejecta, it appears that spinel rich area is part of the ejecta may be excavated from a deeper part of lunar crust which got covered up due to subsequent impacts.

Keywords: Korolev, M3 data, Mineralogy, Integrated Band Depth (IBD), Mg-spinel

HIGH-RESOLUTION CENTENNIAL TO MILLENNIAL-SCALE LATE HOLOCENE MONSOON FLUCTUATIONS IN ZANSKAR VALLEY NORTHWESTERN HIMALAYA

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Abstract

The Holocene epoch is of great importance and interest to understand the earth climate because of the presence of abundant palaeoclimatic records and their possible comparisons and validations through global climate model simulations. Although the Earth's climate history during the late Holocene (~6 ka) has not seen high amplitude changes because the boundary condition of climate system did not change much, however, the conditions were not stationary and low amplitude climate changes undoubtedly occurred. The records of the late Holocene climate variability from the Himalayan region are not only scanty but suffer from large age uncertainty and poor resolution and hence the exact mechanism and the governing factors of the Holocene climate variability still remain fragmentary and highly debated. Keeping this in view, here we present a high-resolution carbon isotope signature ($\delta^{13}\text{C}$) preserved in sediment organic matter (SOM) along with the loss on ignition (LOI), and sediment texture/ grain size to document the palaeoclimate from Zanskar valley.

Centennial to millennial-scale fluctuations of the ISM in north western Himalaya during the late Holocene have been largely modulated by a common forcing associated with internal as well as external forcing with differential spatial responses. These forcing are represented by abrupt climate surges over short time periods are observed in the later part of the Holocene from a ~1.3 m deep sedimentary profile from the Pensi-la, Zanskar Valley. These rapid climate fluctuations on a decadal time scale are very crucial to understand the patterns of climate variability and their forcing factors. Relatively higher $\delta^{13}\text{C}$ values complimented by

TOC, LOI and grain size parameters during Late–Northgrippian imply that the area witnessed a dry climate during (~5100-3500 cal yrs B.P.). A stable climate with moderate precipitation during ~3500-2400 cal yrs B.P. is observed. Since ~2400 cal yrs B.P. a gradual strengthening of ISM is recorded. This gradual strengthening of ISM is interrupted by a high amplitude abrupt reversal (decadal scale dry events) with a step wise decreasing intensity at ~2300, 1500, 1000 and 500 cal yrs B.P. The two most important climate events of the past millennia through Medieval Climate Anomaly (MCA) and the Little Ice Age (LIA) are also recorded in this sedimentary archive.

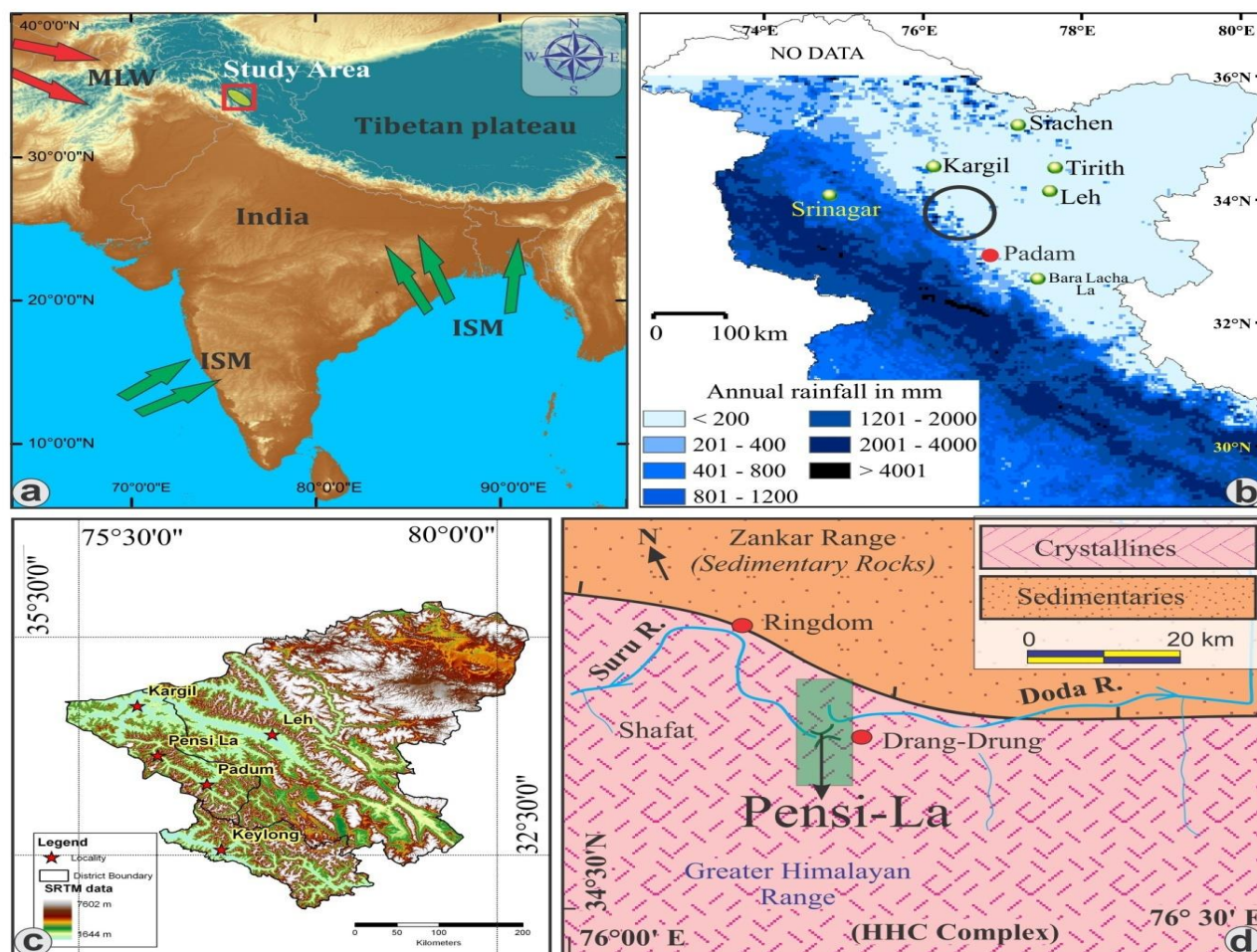


Fig. Map compilation showing, (a) regional setup and the trajectories of the ISM and the mid-latitude westerlies. (b) The cumulative annual rainfall (mm) (after Juyal et al. (2014)). The Circle shows the location of the study site. (c) shuttle radar topographic mission (SRTM) digital elevation model (DEM) of western Himalaya showing the study area (Pensi-la) and other important locations. (d) Geological map of the study area. The Pensi-la (green rectangle) is located in leeward side of the HHC and makes drainage divide between the Suru and Zaskar valley.

IMAGE PROCESSING TECHNIQUES FOR DELINEATING COASTAL DUNE COMPLEX - A CASE STUDY FROM TAMIL NADU, SOUTH INDIA

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Abstract

Coastal sand dunes are one of the most important and sensitive depositional coastal landforms, which act as the buffer zones between the sea and the landmass thus minimizing the destructive effects of cyclone, wave, tide and tsunami. Some of the coastal sand dunes are stabilized due to vegetation cover and some are shifting its position due to lack of vegetal cover. Even though this landform falls in the coastal regulation zone¹, due to indiscriminate exploitation the sand dunes are in danger. Thus, it has to be taken into consideration for maintaining a balance in the coastal ecosystem. Present study focuses on delineation of coastal dune complex by comparing three different sensors namely Landsat 8 OLI, Sentinel 2B, and ASTER with digital image processing techniques like MNF, PCA and ICA. These techniques were used to discriminate the objects and to enhance the hidden features which are not visually analyzed and interpreted in FCC. For this purpose study area from Paramankeni to Alamparai Fort has been selected. Raw satellite images were atmospherically and radiometrically corrected and processed using ENVI and SNAP image processing software's. Noise and dimensionality reduction has been performed with MNF and bands with more eigen values were considered for further processing. The results shows ICA techniques gives more information about the hidden features and also in discriminating the boundary of coastal dune complex from sentinel 2B data followed by Landsat image. Boundaries derived from the image processing techniques were validated using field investigation.

ATTEMPT TO DATE CONTAMINATED QUARTZ USING OSL AND IRSL SIGNALS

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Abstract

Quartz from central Himalaya is not only 'dull' but also 'dirty'. Low sensitivity ($\text{cts.Gy}^{-1}.\text{mg}^{-1}$) is called 'dull', and presence of infra-stimulated luminescence (IRSL) in quartz is called 'dirty'. IRSL is unique to feldspar (particularly K-feldspar) and hence IRSL is not expected from quartz. It is to be noted that this quartz fraction have been separated from the feldspar fraction using magnetic separator, any feldspar coating in the quartz grains would have been dissolved during its treatment with hydro-fluoric acid. Normal practice, in this situation, is to etch the outer layer of the quartz grains using hydro-fluoric acid further. Even after further etching the outer layer, IRSL is observed. This shows that the IRSL has not been arisen from the surface coating but from an inclusion.

It is difficult to separate, physically, the feldspar that is included inside the quartz crystal. There are couple of attempts to date such 'dirty' quartz. One is to suppress the feldspar luminescence signal by exposing the sample to infra-red light before measuring quartz luminescence signal and that is called post IR OSL. Another way is to separate the quartz signal from the feldspar signal using time-resolved luminescence measurements, as quartz (35 μs) and feldspar (0.5 - 20 μs) are separated by their life-times. In this study, we attempted to use luminescence signals from both quartz and feldspar. Earlier it was not possible to measure IRSL during post IR OSL measurements because the filters are different for IRSL and OSL measurements and it was not possible to change the filters during measurement.

In the new Risoe TL/OSL Reader (DASH unit), filter can be changed during luminescence measurements, and we made use of that advancement.

Seven samples (5 samples from central Himalaya and 2 from eastern Himalaya) were selected based on IR depletion ratio (40 - 90 %) which is an indicator of degree of feldspar contamination. Ages based on quartz (OSL) were underestimated by 18 - 30 % compared to the age of feldspar inclusion (fading corrected IRSL). It is to be noted that the dose rates that were calculated for the spherical quartz and feldspar grains of size in the range of 90 - 150 μ m. The dose rate values should be modified and certainly that should be lowered than the ones that are used in this calculation. Correct dose rates can only be estimated once the size and structure of feldspar inclusions are known. The presence of feldspar inclusion in the quartz grains are being investigated using petrological microscope. These investigations will help to estimate the appropriate dose rate values, and hence better depositional ages. Thus obtained ages will be compared with the available AMS radiocarbon ages. Detailed results will be presented in the conference.

GROUND RADIOMETRIC SURVEY OF METASEDIMENTARY ROCKS OF SINGHBHUM GROUP WITH AN IMPLICATION ON URANIUM EXPLORATION

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Abstract

Uranium has become a big issue as an alternative energy resource in the future due to the shortage of fossil fuel as primary energy resources in the world. The state of Jharkhand is blessed by nature with many economic minerals including Uranium. The present study area is underlain by the Precambrian rocks in the western region of Singhbhum Shear Zone. The metasedimentary rock strata are well exposed in the Ukri-Dugni, Seraikella-Kharswan district of Jharkhand which is rich in Uranium mineralization. The principle lithological units in this area include quartz-chlorite/sericite schist, granitic intrusion, and banded magnetite quartzite.

The rocks are highly sheared and folded and many isoclinal folds are preserved. Portable Scintillometer is used for the detailed radiometric survey for estimating the surface concentration of the radioactive elements. Radiation data which reflect the different expected strength, size, size and distribution of sources are collected in the space grid. Isorad map depicts the trend of Uranium mineralization along the Ukri-Dugni tract. The Isorad contour shows the North-South trend of the radioactive anomaly in the study area. Further Cellulose Nitrate film autoradiography studies have been done to characterize the presence of Uranium in magnetite bearing quartzite meta-sedimentary rocks. Analyses of the Radiometric survey revealed Uranium enrichment in the study area and have a positive potential for further Uranium exploration.

Keywords: Uranium, Radiometric survey, Singhbhum Group, Scintillometer, Isorad map.

PREDICTIVE LANDUSE/LAND COVER MODEL OF KALLADA RIVER BASIN USING VEGETATION INDICES AND TERRAIN CHARACTERISTICS

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Abstract

The land use and land cover changes in an area has tremendous impacts in the ecological and socio-economical scenario of that region, among which the impacts in the water resources will be cumulative. Hence there is a growing urge to understand the present and past LULC dynamics of all regions. Spatial technology is considered as the most cost effective and accurate method to monitor and understand the land use land cover changes over a region. The objective of the present study is to develop a discriminant model for the prediction of vegetation classes based on spectral and terrain derivatives in Kallada River basin. A classification system was generated based on a discriminant model, which analyses values of different themes with linear and nonlinear functions of spectral bands and elevation. Discriminant analysis is used to determine variables which discriminate between two or more

naturally occurring groups. Base data were generated from Survey of India toposheets of scale 1:50000, LANDSAT-7 ETM+ imagery and ASTER DEM. As a part of the study, the relationship between 13 vegetation indices and 18 terrain parameters for different land use/cover dynamics were considered. About 85 % of values were correctly classified by the discriminant model with a maximum accuracy for 'water body' with 92.5% and for 'settlement with Vegetation' with 76.4% accuracy.

Keywords: Vegetation index, land use, land cover, Kallada, multiple discriminant analysis

OSL-BASED CHRONOLOGY OF SAND DUNES IN GOLESTAN PROVINCE, NORTHERN IRAN - IMPLICATION FOR PALEOENVIRONMENT RECONSTRUCTION

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Abstract

The development of aeolian deposits, such as dunes and loess, strongly depends on climate conditions and sediment availability. Hence, these landforms can provide valuable information about palaeoatmospheric circulation and wind activity, coastal evolution, paleoclimate and sea level changes. Aeolian deposits are widespread in Golestan Province, in Northern Iran. The loess deposits are dominant in the north-east part of the province, and are part of the Eurasian loess belt. In addition to the loess deposits, several isolated dunes developed on the flat lowland of the Gorgan Plain, which spreads between the Caspian Sea (West), the Koppeh Dag and Alborz Mountains (East and South) and the Karakum desert (North). While the loess chronology in this area is relatively well constrained (>20 ka; Lauer et al., 2017), the formation time of the sand dunes remains largely overlooked, despite their potential to provide valuable information in terms of palaeoclimate conditions and Caspian Sea level reconstruction. In this study, we provide the first reconstruction of dune evolution in the Golestan Province, based on sedimentological description, high resolution

granulometric analysis and optically stimulated luminescence (OSL) dating. Dune geomorphology, grain size distributions and sedimentological investigations indicate a clear influence of the Caspian coast environment on the sediment supplies for dune development, in addition to the probable input from nearby fluvial systems. OSL ages of the studied dunes indicates cluster within less than four thousand years around 10 ka, reflecting a relatively rapid aggradation during the Late Pleistocene-Early Holocene transition. The dunes accretion likely occurred under arid paleoclimate conditions with strong wind activity, and reflects a quick regression of the Caspian Sea during the Late Pleistocene-Early Holocene transition, coinciding with the so-called Mangyshlak regression phase. This is consistent with the apparent spatial and temporal pattern of the dated dunes, which, within age error uncertainty, suggests that the older dunes are located further inland compared to the younger ones. This configuration is characteristic of a low sea level model which is associated with the gradually wider exposure of shelf area to wind activity resulting in shore progradation.

Keywords: Sand dunes, OSL, Palaeoclimate, Iran

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POST DEPOSITIONAL AND DIAGENETIC EVIDENCE FROM LATE HOLOCENE BEACHROCK OF RAMESWARAM, GULF OF MANNAR, INDIA

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Abstract

The reef associated beach rock from Olakudavillage in Gulf of Mannar Islands were studied to assess its diagenetic evidences. Core samples were collected from marine terraces, reef platforms. The presence of corals in the form of framework or isolated patches on the reef flat suggests the rapid increase of accommodation and probably absence of terrigenous and siliciclastic inputs. The massive coral heads above the transgressive phase suggest the

maximum flooding and relatively deepest facies. The freshwater dissolution, association of marine and meteoric cements suggests the semiarid climatic condition with marine diagenesis during sea level lowstands and recharge of freshwater lenses during periodic rainfalls. The incorporation of coral fragments are probably due to the erosion and re-deposition of the sediments.

LATE QUATERNARY RECORD OF THE ENVIRONMENTAL MAGNETIC PARAMETERS FROM THE ANDAMAN SEA

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Abstract

A gravity core (SK 168) retrieved from the Alcock Seamount complex in the Andaman Sea was studied for environmental magnetic proxies for the last 25 cal ka BP. The downcore variations in the magnetic proxies suggest characteristics changes in the sediment sources in turn related with the evolution summer monsoon from the last glacial to Holocene. Magnetic susceptibility (MS) value of sediments is a valuable tool in identifying sediment sources in the Bay of Bengal. MS value in the present study ranging from 7 to 75 X 10⁻⁸m³kg⁻¹. Change in MS value at ~15 cal ka BP in the sediment core may be attributed to the changing sediment sources. High MS value of sediments in the LGM period at ~23–18 cal ka BP indicate relatively high sediment supply from the Irrawaddy, Salween and Sittang rivers compared to Ganges Brahmaputra river system. Low MS values in the sediments deposited after the deglacial period may be attributed to the dominance of the Himalayan River input. The magnetic mineralogy parameter such as S ratio of sediments provides a measure of the relative abundance of soft ferrimagnetic to soft antiferro magnetic minerals. The increase of MS and more coarse-grained magnetic minerals during LGM suggests a decrease in chemical weathering under glacial conditions which may have promoted deposition of more heavy minerals such as ilmenite, rutile, sphene etc. The χ_{ARM} , SIRM and grain size

parameters such as χ_{ARM}/χ_{lf} and $\chi_{ARM}/SIRM$ shows very less values indicate an absence of fine-grained magnetic minerals suggests changes in the weathering environment.

Keywords: Environmental Magnetism, Paleo monsoon, Weathering, Andaman Sea

EVALUATION ON RELATIONSHIP BETWEEN DISTRIBUTION OF DIATOMS, SEDIMENT CHARACTERISTICS AND TRACE ELEMENT GEOCHEMISTRY OF ASHTAMUDI ESTUARY, KOLLAM DISTRICT, KERALA

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Abstract

The study of the Ashtamudi Estuary of the Kollam District was undertaken to know the distribution of diatoms in the core, sediment characteristic and trace element geochemistry of the lake. The sand-silt-clay and organic matter percentage indicate the sub-surface samples consist of sand particles followed by silt. The percentage of organic matter also very less. In the present study, the total of 25 species belonging 20 genera of diatoms were recovered. A total of 369 centric diatoms and 186 pennate diatoms are counted from the samples. But the pennate diatoms show its maximum species richness than centric diatoms. The silty sand nature of sediments favours the maximum growth of diatoms which present in the Zone – I. The diatom population in each sub-surface samples depends on the percentage of the sand and silt present in it. But other factors like percentage of clay, organic matter and trace elements has no significant role in the distribution of diatoms. The distribution of trace elements highly correlated with the percentage of organic matter and clay. The average concentrations of trace elements decreasing in the order Fe>Mn>Cr>Zn>Cu>Pb>Ni.

Keywords: Diatoms, Ashtamudi Lake, Trace elements

SEA WATER INTRUSION IN COASTAL AQUIFERS FROM POOVAR TO SHANGUMUGHAM, THIRUVANANTHAPURAM, KERALA

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Abstract

The coastal aquifers in Kerala are experiencing seawater intrusion due to overexploitation in order to meet the demand of the growing population. So a study was conducted on coastal aquifers from Poovar to Shangumugham, Thiruvananthapuram district, Kerala state in order to find out the status of sea water intrusion in the area. Groundwater samples were collected and the quality and impact of saltwater intrusion were studied by determining the geochemical characters of 78 groundwater samples collected during pre-monsoon and post-monsoon each. Physical parameters and chemical parameter major cations and anions are determined. The data were analyzed and the multi variate analysis was carried out using SPSS 24. The correlation and R-mode factor analysis confirms the presence of sea water intrusion and using Q-mode factor analysis the areas affected by sea water intrusion is demarcated. Thus, the groundwater of the study area has to be managed sustainably considering the geochemical nature and their seasonal variations, as region proposed for study is a coastal fragile environment.

Keywords: Salt water intrusion, Hydrogeochemistry, Coastal Aquifers

SELECTION OF SITE FOR SURANGAMS IN KASARAGOD: GEOMORPHOLOGY, STRUCTURE AND PLANT INDICATORS

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Abstract

Surangas are cave-like structures dug through lateritic hills and slopes, and acts as passageways to the lateritic reservoirs of rainwater. This traditional water harvesting system is still known and dug by limited number of skilled laborers. The North-East and South-West monsoon rejuvenates the lateritic hills. These lateritic hills acts as reservoirs and thus are rich sources of groundwater. Even hard rocks like granites, gneisses and charnockites are also exposed along the course of Surangas. Field observations made on 25 surangas of Perla region showed that, confluence of two valleys is found to be ideal which is the first consideration by the workers. This is followed by geo-botanical indicator to which villagers consider a plant known as 'Nekkare'(local name) in thulu (thulu is a regional language in Kasaragodu). This plant is similar to *Dicranopteris linearis* found in newly soil accumulated regions in appearance and its specilities in hydrophilic characters are yet to be explore. It was found that, their belief in considering that plant as a groundwater indicator is of considerable importance as diversions taken from inside the surangas in different directions do not found to be yielding equally with the yields shown in the direction of spread of this plant. Even though upper layers are of lateritic soils and then clay, metamorphosed and altered crystalline rocks were also found when we go deep inside the surangas. It was observed that, surangas are cut in such a fashion that the trend of foliations planes and lineaments are cutting across the length of the suranga which facilitates enough infiltration to the structure. At the end of the suranga, it usually meets with hard fractured crystalline rocks (present case, charnockite) which also accounts to the yield of the well. Surangas are very much similar to Qanats in their technologies, being underground tunnels, which act as conduit for groundwater. In the context of intensification of drought conditions in various parts of the

district, water harvesting systems like Surangas are one of the few methods for copious and clean source of water.

Keywords: Surangam, Kasaragod, Laterite

ASSESSMENT OF SHORELINE VULNERABILITY ALONG THRIKARIPUR AND SHIRIYA COASTLINE, KASARAGOD, KERALA, INDIA

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Abstract

The Shoreline is the strip where a large body of water like an ocean, lake or river meets the land. The changes in the shoreline often result in coastal erosion or accretion because it is extremely vulnerable to the natural hazards. The changes are over time scales including minutes, hours, decades and centuries. Spatial changes vary from local to regional to worldwide. In the present study, investigates on long term changes in the shoreline of estuaries of Thrikaripur and Shiriya river were carried out using multidated data for 2004 to 2018 and toposheet of 1967. Arc GIS 10.3 software used for the image processing. Based on this study the area undergoing accretion and erosion are identified and the mouth of the Shiriya river has varied in its shape, pattern and position during the course of time. The construction of the seawalls in the estuary preventing the shoreline from erosion and accretion. The present study highlights the significance of GIS (Geographic Information system) techniques in coastal geomorphology and shoreline changes. The up-to-date and reliable shoreline information is essential for shoreline management purposes.

Keywords: Shoreline changes, Estuary, Accretion, Erosion, GIS

MINERALS, METALS AND SOCIETY

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Abstract

Human development is marked by the increasingly complex use of the earth's mineral resources, both metallic and nonmetallic as well as building stones, over a period spanning at least 3 million years. There are more than three major uses for many elements in the Periodic Table today. Ever widening base of mineral use has made minerals an integral part of our everyday life. One is familiar with the modern human being: clothed and bespectacled inside an automobile, connected by phone wires and radio waves to cellular phones, modems and bank machines, supplied with electric energy, plumbing and other utilities – a transformed meta-human being, with such transformation made possible through technological developments based on materials extracted out of the mineral world in the earth's crust. But unfortunately, most of us take for granted the importance of minerals and metals. Hardly any user of high-end smart phones knows that the device they are using may contain precious metals like gold (0.034 gm), silver (0.34 gm), copper (15 gm), platinum (0.001 gm), and palladium (0.015 gm) besides an array of rare earth elements.

Mineral resource supplies have thus become a global issue today. In the past, developed countries have consumed far more than their per capita share of world mineral production. China has now become the largest consumer of mineral resources globally. As underdeveloped countries strive to become developed, demand for minerals, actually a wider array of minerals, is growing steadily. It is possible that we may run out of the minerals as demand exceeds supply. Though urban mining (recycling) is increasing (with the e-waste Mountains having an estimated 55 billion dollars of precious metals) and has a lower carbon footprint than mining, it can never satisfy demand. While a section of our society seeks a significant reduction in new mineral production through conservation and recycling, others believe that new developments in mineral exploration can find new resources to meet the demand. As we are increasingly dependent on materials to support our way of life, our health and the global economy, it is vitally important to

understand the science of mineral resources and materials. Mineral geosciences (geology, geochemistry, geophysics, geometallurgy, geoenvironmental engineering) can aid in meeting the demand and help the world locate and exploit mineral resources in an environmentally friendly and sustainable manner.

There are complex challenges today in the extractive industry – the Mines & Minerals sector, particularly in fast developing countries like India. A thick web of technical, socio-economic, environmental, financial and political/regulatory issues make finding and developing a mineral deposit a particularly difficult task. These issues are now in-built into the UNFC classification of resources. All agree that the mineral industry is an important source of economic activity and jobs, and a major contributor to wealth creation. But its *sustainable development (SD)* is crucial to the environmental integrity of a project and promotion of inclusive growth of our society, particularly welfare of local (often indigenous) communities and in poverty alleviation. However, it should be remembered that all tenets of SD cannot be satisfied in the extractive industry, particularly the issue of intergenerational equity. The social and economic relationship should be understood in terms of *conversion of capital from one form to another*. A *natural resource capital* (the mined ore body) is converted into products with many uses and sold to generate *economic capital* which can be reinvested to create or enhance other forms of capital: *human* (skill, knowledge), *social* (co-operative networks, community organisations) and *physical* (roads, schools, hospitals).

RELEVANCE OF FIELD OBSERVATIONS IN UNDERSTANDING GEOLOGY OF REGION: DEMONSTRATION FROM THE ARCHAEOAN DHARWAR CRATON, INDIA

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Abstract

Interpretation of satellite imageries without follow up geological studies, application of advanced geochemical instrumentation without proper evaluation of field geological and petrological

observations, acritical application of results of geophysical studies to interpret past geological evolution of a region have led to gradual neglect of classical geological methods in understanding the evolution of the earth's crust. As a presentation by unrepentant field geologist this talk will demonstrate the significance of field geological observations even to-day. The examples drawn are from the Archaean Dharwar craton of India with which the presenter is familiar.

In the classification of the Dharwar Supergroup, the conglomerates at the base of the Bababudan and Chitradurga Groups serve as stratigraphic markers to define the base of the Bababudan Group and the Chitradurga Group of the Dharwar Supergroup. There is no substitute to field observations for understanding the environment of their sedimentation. The textural and mineralogical maturity as well as nature and orientation of trough cross bedding in the conglomerates indicate that the quartz pebble conglomerates at the base of Bababudan Group are deposits of braided fluvial plain. The polymictic conglomerates at the base of the Chitradurga Group show their diamictite nature, and drop stones in them imply glacio-marine origin for these conglomerates. Sedimentary structures in these conglomerates apart from giving clues to paleogeography, tell us about the palaeoclimates as well. Stromatolites, especially colonial columnar forms, largely grow in the tidal zones of the seas in tropical to sub-tropical zones. Thus, they uniquely define the palaeo coastal margins.

Synoptic view provided by satellite imageries can give clues to the hidden geological structures in a terrain. However, structural mapping and observation of structural features from out crop to map scale is a must for understanding the structural evolution. For example, outcrop patterns seen on satellite images indicate superposed folding in the Dharwar terrain. They do not however tell whether the structure is the result of continuous or discontinuous deformation. Detailed structural mapping of critical regions, understanding of megascopic and microscopic structures and related metamorphic fabrics are required to decipher the tectono-metamorphic history. Such observations have led to understanding of style, sequence and orientation of structures in the Dharwar craton. Similarity of tectono-metamorphic history or structural history has implications for understanding whether a craton has resulted from a single terrane or is a mosaic of more than one terrane. Such a similarity of structural history in the eastern and western Dharwar craton suggests that the two terrains are not separate terranes that are sutured. Geochronological studies that do not match observable geology need to be critically evaluated.

Nature of a fault, as to whether it is normal, reverse (thrust) or strike slip cannot be decided by observation of satellite imageries. It requires detailed study of stretching lineation's and strain

markers in the fault zone. Moyar fault for example was interpreted as a strike slip fault based on inferences from LANDSAT imagery interpretation. Detailed field observation of stretching lineation's and strain markers in this fault zone, however clearly demonstrated that it is strictly a dip-slip fault. Bhavani fault is an oblique slip fault with stronger dip- slip component. Nilgiri Block in between these two faults is a horst. Palghat-Cauvery fault is another fault which was interpreted from satellite imagery as strike-slip fault, but structural mapping shows it to be a north dipping thrust.

Geophysical structure of the earth's crust represents the present-day structure of the earth. It does not tell the geological history without support from geological studies. For example, the Dharwar craton which was formed by crustal differentiation processes 2550 Ma ago was affected by Proterozoic and End Cretaceous plume related magmatism and Eastern Ghats and Eocambrian orogenies. Interpretation of crustal thicknesses and their significance for crustal suturing based on seismic tomographic evidences must not ignore post- cratonization crustal history.

EARTH'S MOON: GEOLOGY AND RESEARCH HIGHLIGHTS

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Abstract

Moon is the only recognized natural satellite of the Earth. Moon has always been a celestial object of great interest among planetary geoscientists in terms of its origin and evolutionary history. Moon is believed to be formed as a result of the impact of a Mars-sized body called 'Theia' with the proto-earth at around 4.5 Ga ago [1]. The ejecta fragments from the 'Theia' and the crust and mantle of the proto-earth were thrown off to the orbit around the earth and re-accreted to form the Moon. Huge energy was released due to the collision and accretion which was sufficient to melt the infant Moon up to considerably greater depth and formed a magma ocean. Lunar Magma Ocean (LMO) hypothesis suggests that the Moon was formed into a differentiated body followed by the completion of crystallization of the magma ocean [2]. The early formed olivine crystals

from the magma ocean underwent gravity settling and became a significant part of the lunar mantle. The anorthite crystals formed in the final stages of the magma ocean crystallization floated upward due to its relatively less density and formed the primary anorthositic crust of the Moon. Bright highland regions (~4.4 Ga old) on Moon are primarily composed of these anorthosites. After the formation, the Moon was constantly hit by asteroidal bodies of varying sizes and velocities throughout its geological history. Such large scale impact cratering events as well as other intrusive and extrusive processes have largely modified the Moon since its formation. The dark coloured Maria regions on Moon was formed by eruption of low-viscosity basaltic magma through fissures/cracks resulted from the crustal weakening due to such impact cratering events. Maria volcanism continued for ~700 Ma. Many magnesium rich rocks such as dunite, norite and troctolite are found to be associated with the primary anorthositic crust of the Moon indicating a deeper source for anorthosites on Moon. There is an asymmetrical distribution of crustal thickness between nearside and farside of the Moon. Most of the Maria basaltic plains are concentrated in the crustally thinner regions on the nearside whereas the thickest crust is observed in the feldspathic highlands on the farside of the Moon. This nearside-farside crustal asymmetry is a major aspect which has not fully been answered yet. Olivine, pyroxenes, plagioclase, ilmenite and spinels are the major minerals identified on Moon. Chemical and thermal history of these minerals would give information about the evolutionary history of the Moon. In addition, the conditions prevailed at the time of formation of Moon is preserved in the lunar rocks, unlike Earth. Therefore, studying lunar rocks and constituent minerals would shed light on the history of origin and evolution of the Earth-Moon system. A new rock type called Pink-Spinel Anorthosite was recently detected on the lunar surface. PSA contains no/ <5% mafic components. The probable mechanism proposed for the formation of these minerals is the interaction of Mg-rich melt with the anorthositic crust [3]. OOS (Olivine-Orthopyroxene-Spinel) lithology in the peak rings of Moscoviense basin was also a significant detection which has inferred about the endogenic origin of these lithologies. Detection of Mg-Al spinel in association with pyroclastic deposits was proposed to be formed by eruption of magma containing Al-rich zone produced by the assimilation of the anorthositic crust. Olivine-rich rock types of mantle origin were also detected from the SPA (South-Pole Aitken) basin on Moon. Exposures of such deep-seated rocks on the lunar surface have implied to the mantle overturn which would have been occurred after the completion of the crystallization of Lunar Magma Ocean. Therefore, detailed chemistry of these mineral bearing lithologies has to be understood to place constraints on their

origin and mechanism of transport. Furthermore, Moon has had a strong magnetic field at 4 Ga ago, unlike present. The Moon with a smaller core couldn't have produced such a strong magnetic field and this is an unsolved problem yet. Several models were proposed in favour of this strong magnetic field in the early history of the Moon. Scientists attributed the lunar basal magma ocean to the convection that drives the dynamo for creating a magnetic field [4]. In the later stages of lunar evolution at ~3.5 Ga ago, the strong magnetic field of the Moon became weak and it continued until recent. This phenomenon was explained by the complete cooling of the magma ocean and the core dynamo would still have continued to produce a weak magnetic field. However, certain regions on Moon which are distinctively brighter, named as lunar swirls is thought to be a result of weak space weathering effects due to deflection of cosmic radiation by the anomalously high magnetism over such regions. Such lunar swirls are yet a mystery to be solved. Discovery of water ice deposits on the lunar poles was a major discovery by Chandrayaan-1 mission. Hydroxyl related absorption in association with olivine was another significant observation from Chandrayaan-1 data [5]. Source and origin of these water molecules as well as its association with primary mineral like olivine are not fully answered yet. The composition of these associated minerals can be used to infer about the origin of water/hydroxyl molecules. If the water molecules are associated with any of the primary mineral assemblages, an endogenic origin can be proposed. Furthermore, the craters in the permanently shadowed regions on the lunar South Pole are potential sites for exploration. This region was speculated as mineral rich region. The bottom of these craters (cold traps) never receives sunlight and might store record of the early solar system conditions as it has not been modified by the effects of space weathering and other chemical processes. Detection of water ice deposits from these craters make them more significant. In the current scenario, technological limitations for the in-situ studies of Moon hinder our efforts to understand the earth's closest neighbour. Planetary analogue research gains its importance in this scenario. Terrestrial rocks and minerals which are analogous to the lunar rocks would be studied in order to understand their genetic history which in turn help us infer about the origin of similar rocks on the Moon. Besides, understanding the physical and chemical characteristics of terrestrial analogue rocks would be helpful in the instrument calibration as well as test bed experiments for future lunar missions [6].

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APPRAISAL OF ARSENIC CONTENT IN GROUNDWATER AND ITS IMPACTS: AMBAGARH CHOWKI, CHATTISGARH

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Abstract

This present study has highlights the occurrence and extent of arsenic levels in groundwater at Ambagarh Chowki including the health aspects of arsenic in groundwater on local people. The geographic distribution of high arsenic in groundwater is sporadic in occurrence. Total of 52 and 60 water samples have been collected during pre-monsoon and post-monsoon respectively for analysis of arsenic. Chemical analysis of ground water samples indicate that most of the samples show high arsenic content during pre-monsoon period, which may be due to declining of water level during pre-monsoon period followed by release of arsenic from formation to pre-monsoon period. The commonly reported symptoms of chronic arsenic exposures in the study area are melanosis, hyperpigmentation, depigmentation, keratosis, gangrene, peripheral vascular disorder, skin cancer and a number of internal cancers.

Keywords: Arsenic, Groundwater, Chandigarh, Health impacts

STABLE ISOTOPIC CHARACTERIZATION OF PRECIPITATION IN A SEMI-ARID REGION, KALBURAGI, KARNATAKA STATE, INDIA

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Abstract

Monthly composite precipitation of samples was analyzed for isotopic characterization for two years from 2016 to 2017 in a semi-arid region Aland Taluk, Kalaburagi district, Karnataka State. The rainfall during the southwest monsoon showed distinctive isotopic signatures. Precipitations in the month of July and August revealed their marine identity with an average value of $\delta^{18}\text{O}$ (-1.93‰) and the low average value of deuterium excess (9.31‰) that this may be considered as the best representation of southwest monsoon precipitation. Whereas the $\delta^{18}\text{O}$ values pertained to the month June and September precipitation samples were slightly depleted of the isotopic signature with an average value of $\delta^{18}\text{O}$ (-4.38‰) and higher deuterium excess value (10.72‰). This study helps to understand the existing knowledge gaps in the understanding of water isotope systematic of precipitation connected with the area of study.

Keywords: Oxygen-18, deuterium, monsoon, precipitation.