ISERME 2020

International Symposium on Earth Resources Management & Environment



22nd December 2020 Colombo

ABSTRACTS

Organized By

Department of Earth Resources Engineering University of Moratuwa, Sri Lanka



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International Symposium on

Earth Resources Management & Environment

22nd December 2020, Colombo, Sri Lanka

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Message from Dr. G.V.I. Samaradivakara - Symposium Chair

Welcome to the fourth International Symposium on Earth Resources Management and Environment [ISERME 2020], organized by the Department of Earth Resources Engineering, University of Moratuwa, Sri Lanka.

A revolutionary change in the departmental research culture took place fifteen years back, and in 2005 with the implementation of World Bank funded project for Improving



Relevance and Quality of Undergraduate Education [IRQUE]. We are grateful the "IRQUE" Project for encouraging and funding the department to organize the first annual research conference in 2006, which eventually evolved up to an International Symposium in 2017.

Since 2016, the department has been networking with the international Mining Engineers and Earth Scientists in organizing this symposium annually.

This year, we had scheduled to hold this symposium in Hokkido, Japan based on the collaboration that we have with Hokkaido University. We are so grateful Professor Satoru Kawasaki of Division of Sustainable Resources Engineering, Faculty of Engineering, Hokkaido University for his excellent support given in planning this. However, as per unexpected circumstances aroused due to spreading viral, we had to decide Colombo as destination for this year symposium.

On behalf of the Department of Earth Resources Engineering, I wish to extend my sincere thanks to Professor N.D. Gunawardena, Vice-Chancellor of the University of Moratuwa and Professor N.K. Wickramarachchi, Dean-Faculty of Engineering of the University of Moratuwa for granting their kind permissions for this symposium.

I greatly appreciate Professor Mrs. Dileeka Dias, Dean-Faculty of Graduate Studies of the University of Moratuwa for providing "Zoom Room" facility in the Faculty for hosting this Symposium online. The external reviewers of the symposium are appreciated for their timely given insightful reviews. Thanks are also extended to all the authors for their excellent submissions made to this symposium.

I'm certain that this symposium will continue to network with all the researchers in the fields of Mining and Earth Resources Engineering.

I also look forward to meeting with all of you again at ISERME 2021, with a wider participation of international researchers having similar research interests, in the coming year.

I wish you all, a productive and enjoyable Symposium!

Dr. G.V.I. Samaradivakara - Symposium Chair - ISERME 2020 Head - Department of Earth Resources Engineering, University of Moratuwa 16th December 2020

Message from Eng. P.V.A. Hemalal - Symposium Secretary

It is with great pleasure I fulfill the responsibility of coordinating the activities leading to ISERME-2020 the theme "Earth Resources Management and Environment" as the coordinator. The symposium is no doubt the greatest annual academic event of the Department of Earth Resources Engineering of the University of Moratuwa. I consider it an honor to play a pivot role in organizing activities leading to this great event, networking with many organizations and individuals.



The event brings together many academics, students, industry leaders, alumni and well wishers and is graced by the Eng. U.S. Karunarathne, Chairman, Central Engineering Consultancy Bureau, as the chief guest and Eng. Manju Gunawardena, Chief Executive Officer, Ceylon Graphene Technology (Pvt.) Ltd., the key-note speaker.

This forum provides an ideal opportunity for the students to mix along with the senior industry professionals and industrialists and learn firsthand the new trends of development in the industry and in academia elsewhere and, sharpen one's skills to suit the changing circumstances. In an informal setting, the academics will also have a chance to feel the pulse of the industry and exchange views which will help guide future research.

I hope that the theme is an inspiration to the young professionals to chart their future role as there is still a lot to be done to tap the vast potential of industrial minerals in the country and accordingly plan their future and make themselves ready to undertake the future management of country's mineral resources raising the stature of the industry to greater heights.

I sincerely thank all the academic colleagues for the valuable advice offered, nonacademic staff members and the student body effectively fulfilling the individual tasks undertaken to make the event a success. This event would not have been possible without the financial assistance of the sponsors.

Eng. P. V. A. Hemalal Senior Lecturer – Symposium Secretary ISERME 2020 22nd September 2020

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Session I: Mining and Geomechanics

Fragmentation Optimization in Aggregate Quarrying in Sri Lanka	3
Technical, Socio-environmental & Procedural Limitations in Sri Lankan Quarry Industry from the Mining Engineer's Perspective	4
An Investigation of Industrial Mineral Mining Methods in Sri Lanka	5
Mining-induced Subsidence Prediction by Displacement Discontinuity Method	6

Session II: Mineral Exploration, Groundwater Studies, Ocean Resources Engineering and Petroleum Engineering

Analyzing the Groundwater Characteristics Using Numerical Models **9** for Groundwater Management in Attanagalu Oya Basin

Rare Earth Elements Exploration in River Sediments (Belihul Oya and **10** Samanala Wewa Areas, Sri Lanka)

Mineralogical Exploration for Rare Earth Element Potential in Kalutara **11** Coastal Areas

Developing a Casing Program for the Extraction of Petroleum in **12** Mannar Basin, Sri Lanka

Assessment of Rare Earth Element Potential in Intrusive Rocks Special 13 Reference to Massenna Zircon Granite

REE Potential in Carbonatite Deposits: A Case Study of Eppawala 14 Carbonatite

Session III: Mineral Processing and Environmental Engineering

Remote Sensing Analysis of Urban Heat Island Effect in Colombo City 17 from 2001-2019

Feasibility of Extraction of Cerium dioxide (CeO₂) from Monazite at **18** Pulmoddai

Monitoring Beach Profile Changes and Modelling Nourishment **19** Scenarios for Ratmalana Beach

Heavy Mineral Sands in Kirinda Area, Deposit Characteristics and 20 Extraction Potential

Selective Precipitation of Lanthanum and Neodymium oxides from 21 Pulmoddai monazite, Sri Lanka

Adaptation to Future Flooding in a Lowland City, A case of Jakarta 22 City

Estimation of the Number of SARS-CoV-2 Infections in a Sewershed 23 Based on Wastewater-based Epidemiology Abstracts of ISERME 2020

Session I Mining and Geomechanics

Abstracts of ISERME 2020

Fragmentation Optimization in Aggregate Quarrying in Sri Lanka

Edirisinghe EAAV, Kaluarachchi KAUM, Lakmal WYP *Samaradiwakara GVI, Hemalal PVA and Chaminda SP

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Rock breakage by blasting is an essential feature in size reduction in the aggregate quarrying industry. Uniform size distribution of blasted rock material, is as an index of the efficiency of bench blast design. The extent of rock fragmentation in the blasting process influence the efficiency of all the subsystems such as crushing, loading and hauling in the mining operation. To achieve optimum rock fragmentation, a blast with optimized controllable parameters should be designed so that the effects of the uncontrollable parameters could be minimized. Numerical Modeling based software is widely used in many countries with developed mining industries for bench blast simulations, in order to optimize blasting. However, in Sri Lanka, quarry rock blasting is tradition-bound and blasting software is rarely used in the industry. The main objective of this research was to design the most economic blast that will delivers the optimum fragmentation, using "JKSimBlast - 2DBench" software. Blast simulation was done using JKSimBlast software for the blast design practiced on site, based on average physical property values obtained in rock testing. A large number of blast simulations were done by changing blasting parameters and a selected number was subjected to test-blasting in actual conditions. In muck pile fragmentation analysis, muck file photographs were analyzed by means of "Split Desktop" software with the results compared with the predictions in JKSimBlast software followed by the application of the Kuz-Rum fragmentation model.

Keywords: Blasting, JKSimBlast, Kuz-Ram model, Simulation, Split Desktop

Technical, Socio-environmental & Procedural Limitations in Sri Lankan Quarry Industry from the Mining Engineer's Perspective

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Over 2500 quarry sites are currently in operation to cater the large requirement of rock aggregates for construction and development activities in Sri Lanka. The concerns of this industry are not limited to the environmental and social aspects but significantly influence its own functionality. Even though such instances are common and under regular discussions, documented evidence, and efforts to methodically resolve them finds to be limited. Hence, only the adverse effects of the quarrying industry are mostly highlighted, sidelining the opportunities for sustainable development. This research attempts to systematically document the issues in the quarrying industry in Sri Lanka to address them based on three broader categories; Technical, Socio-environmental and Procedural. As an initial exercise the collected survey data was categorized on district basis, quarry grade, respondent's skill level and the nature of the interviews conducted. Through cross analysis of these data clusters the most common concerns were extracted to prioritize according to the level of significance for the future of the quarrying industry. Afterwards, statistical significance of the relationships among the issues so far identified was computed mainly using Chi-squared-tests and the Binary Logistic Regression on SPSS software. Findings of this pilot study can be used for future policy development, even though they are dominantly represented by the Colombo, Kalutara and Gampaha districts.

Keywords: Aggregates, Binary-Logistic-Regression, Chi-squared-test, Mining industry

An Investigation of Industrial Mineral Mining Methods in Sri Lanka

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Sri Lanka is endowed with a rich base of industrial minerals despite its small land area. Traditional and modernized mining methods are employed to mine graphite, limestone, beach mineral sand (ilmenite, rutile, zircon and garnet), apatite, calcite, dolomite, quartz, feldspar, clay, kaolin, silica sand, mica and rock aggregate. Notably, some deposits have not been optimally exploited to their potential. Moreover, Sri Lanka does not have comprehensive information and documentation in the mining context. The mining method is selected on the basis of respective geology of the deposit, hardness of the ore and rock, depth, thickness and other geological aspects etc. The extraction of narrow steeply dipping vein deposits and deposits at great depth are significantly challenging and need specified selective mining techniques. In the study, currently practiced mining technologies, Cut-and-Fill mining at Bogala, Open-stopping at Kahatagaha mines, open cast mining at Aruwakkalu Limestone guarry and mineral sand mining at Pulmoddai were investigated. The investigation was carried out through interviews and field visits. Site characteristics of each mine were tabulated, and the mining procedures were discussed. Mining methods employed at Kahatagaha and Pulmoddai were traditional while Bogala and Aruwakkalu utilize more systematic technologies. It is recommended to investigate and conduct indepth analysis in the second phase of the study for technological improvements.

Keywords: Cut and fill, Mining method, Open pit, Open stope, Placer mining

Mining-induced Subsidence Prediction by Displacement Discontinuity Method

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In the longwall coal mining method, subsidence is allowed, and because of that, the stress-induced accidents are lower in this mining system, having a higher production rate. As subsidence is a must in a longwall coal mine without stowing, it is essential to predict the mine-induced subsidence for sustainable mine management. In this research, we have tried to predict the mining-induced subsidence by the Displacement Discontinuity Method (DDM) of the Barapukuria longwall coal mine. The total area of the coal mine is about 6.68 km², which has a reserve of 390 million metric tons with an average main seam thickness of 36 m bounded by faults and structural discontinuities. The mining depth varied from 290 m to 480 m in the coal seam having an average inclination of around 10°. The mine is divided into Northern Upper Panels (NUP) and Southern Lower Panels (SLP), and subsidence happened with two subsidence epicenters. The maximum observed-subsidence having a noticeable areal extent due to NUP and SLP is 5.8 m and 4.2 m, respectively, after extraction of around 10 m of the thick coal seam.

The numerical model of the mine was prepared by considering major discontinuities and the panels. The predicted subsidence and the observed subsidence due to the NUP and SLP were compared varying Young's modulus, and the 0.10 GPa Young's modulus was found to be the best match for both the panels. Whereas, Young's modulus of 0.30 GPa and 0.05 GPa showed the under-predicted and over-predicted subsidence. Future subsidence is predicted by considering 30 m extraction of the thick coal seam. By choosing a suitable Young's modulus value in the DDM, mining-induced subsidence could be predicted for particular geo-environmental conditions. The numerical simulation could be used for future mining for sustainable mine management.

Keywords: DDM, Young's modulus, Longwall coal mining, Faults, Dyke

Abstracts of ISERME 2020

Session II

Mineral Exploration, Groundwater Studies, Ocean Resources Engineering, and Petroleum Engineering

Abstracts of ISERME 2020

Analyzing the Groundwater Characteristics Using Numerical Models for Groundwater Management in Attanagalu Oya Basin

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Due to the increase in population, climatic fluctuations and water pollution, scarcity for drinking water become the greatest threats all around the world. Sri Lanka is considered as a country with little or no water scarcity when considering the whole country as one unit. However, several regions with temporal water scarcities have been identified by past studies. Attanagalu Oya basin which covers almost the entire Gampaha district is a major hydrologic feature in determining the groundwater characteristics of the region. In this study, the ground water characteristics in the Attanagalu Oya basin was analyzed quantitatively to identify the periodical variations. The ground water quantity variations were observed through data loggers and field surveys in Attanagalu Oya basin. These recorded values were used to model the ground water resources in the region using two numerical modelling methods Visual MODFLOW by USGS and a self-written Fortran code. Fortran code is mainly used for the surface runoff modelling and Visual MODFLOW focused the subsurface modelling. Those quantitative variations of the groundwater were then analyzed spatially and temporally to correlate the upstream to downstream flow and the monsoonal recharging impacts. The possible reasons for the observed deterioration and variations in the groundwater quantity in the Attanagalu Oya basin can be analyzed as keys to provide recommendations for sustainable management of the groundwater resources. It can be clearly observed that the difference between the water recharge and discharge to the subsurface based on the model shows abnormally lower values throughout the study period and thus, the groundwater is deteriorating in the basin without any considerable storage.

Keywords: Fortran, Groundwater Modelling, Quantity, Scarcity, Surface Runoff, Visual MODFLOW

Rare Earth Elements Exploration in River Sediments (Belihul Oya and Samanala Wewa Areas, Sri Lanka)

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Rare Earth Elements (REEs) are the most critical elements in the world due to their diversified applications in the modern high-tech and green technologies. As a result of the continuous increase in the global REE demand, new REE exploration projects are being launched, worldwide. REE occurrences are mainly classified as primary and secondary deposits, whereas alluvial placers are a subset of the secondary REE deposits. Previous geochemical studies of alluvial beds in Sri Lanka have disclosed significant concentrations of REEs. Moreover, the Walave river basin is located at the boundary between Highland Complex and Vijayan Complex, which is a highly mineralized belt. Therefore, this study is focused on assessing the REE potential of stream sediments in Samanala-wewa reservoir and its upstream and downstream areas (i.e. Walawe river basin). The collected samples (n=26, covering 9 locations associated with Walawe river, Belihul Oya, Hiriketi Oya and Denagan Oya) were processed (< 63 µm grain size) and analyzed using XRD to identify their mineralogy. Monazite, bastnaesite, loparite and xenotime are the major RE minerals found in these samples. Moreover, the sampling locations could be confined to six stream paths, the correlation was found between the stream order, and the number of REEs present at the location. Overall, this study provides a qualitative interpretation for the REEs present in Rare Earth bearing minerals in the stream sediments of the study area. However, detailed quantitative analyses are required to further assess the true REE potential in this prospect.

Keywords: Alluvial placer deposits, Rare Earth Elements, Sri Lanka, Stream sediments, Walawe river basin

Mineralogical Exploration for Rare Earth Element Potential in Kalutara Coastal Areas

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Calido Beach is a coastal region where Kalu-Ganga joins the sea in Kalutara, Sri Lanka. In this study, this coastal region is divided into four main divisions as Kalutara North (KN), Kalutara South (KS), Sand Spit (SS) and the river delta for prospecting Rare Earth Mineral (REM) sources (especially Monazite). Beach sand samples (n=30) and river sediment samples (n=5) were collected covering all four regions and were analysed for mineralogy, grain size distribution and microscopic observation. Mineralogical analysis via X-ray Diffraction (XRD) revealed positive availability of REMs such as Monazite (Ce), Monazite (Nd), Xenotime and Bastnasite. As per the results, river delta is enriched with Monazite (Ce) whereas KS coast is enriched with Monazite (Nd). This delineates the fact that source for Monazite (Ce) is the river outlet of Kalu-Ganga and sources for Monazite (Nd) could possibly be Beruwala placer deposit, offshore sources and/or longshore currents. Microscopic observations revealed that KS coast consists of higher volume percentages of Monazite compared to other locations. According to grain size distribution (GSD) results, samples from KN, KS and SS demonstrated a transition from poorly to very poorly sorted condition while sediments from delta showed extremely poor sorted conditions. This reflects that sediments in delta had a lesser time for sorting before deposition with relevance to beach sand. However, this nourishment of REMs into the shore increases the amount of REM content in the study area and the minable quality of beach sand as an economically viable REE source.

Keywords: Calido Beach, Monazite, Particle Size Analysis, Rare Earth Minerals, X-Ray Diffraction

Developing a Casing Program for the Extraction of Petroleum in Mannar Basin, Sri Lanka

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To develop an economical casing design program for the Mannar basin which is safe, and risk minimized, knowledge on Pore Pressure Gradient, Fracture Pressure Gradient, Casing Performance Properties and Casing Design Criteria's are important. Previous studies present the Hottman and Johnson method and D-exponent method-Eaton as accurate methods to predict the pore pressure gradient of the Mannar Basin and the Ben Eaton method as the most accurate method to predict the Fracture Pressure Gradient of the Mannar Basin. The data extracted from the final well reports and pressure reports of the pearl 1 well of the Mannar basin are analyzed using the above models to accurately predict the Pore and Fracture pressure gradients of the Mannar Basin. Casing setting depth of each casing type was selected by plotting the predicted fracture pressure and pore pressure data with the depth.

The casing sizes were calculated using the casing performance properties of burst, collapse and tension.

For the calculations, safety factors were selected according to the industry standards and a safety factor of 1.1 was used for the burst and collapse pressures and a safety factor of 1.6 was used for the tension and compression forces.

The predicted data shows that the pore pressure and the fracture pressure gradients of the Mannar basin are comparatively low. Therefore, after considering the effects of earthquakes on the casing, casing grades with minimum safety requirements can be used in the drilling activities in Mannar basing.

Keywords: Fracture Pressure, Pore Pressure, Casing Setting Depth, Burst, Collapse, Tension

Assessment of Rare Earth Element Potential in Intrusive Rocks Special Reference to Massenna Zircon Granite

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Rare earth elements (REEs), a group of seventeen elements, including the fifteen lanthanides plus yttrium and scandium, are extensively used in the high-tech and green technologies. With the escalating global demand for REEs and China's monopoly over global rare earth element (REE) supply, the exploration for new stocks of REE ores is of immense economic significance. Therefore, many countries are now actively engaged in the exploration of new and alternative sources of REEs. Moreover, finding lowgrade REE sources can be commercially viable in future due to the REE scarcity, resulted by ever-increasing demand. In this regard, Sri Lanka also has several geological formations, which might be enriched of REEs. Therefore, this research is focused on assessing the REE potential in zircon granite in the Massenna area, Balangoda with comparison to the pegmatites in Matale/Kandy area. A total of 18 rock samples were collected from pegmatitic bodies located in Balangoda and Matale areas. In addition, 4 insitu soil and 3 sediment samples were collected from the close vicinity of the pegmatite bodies. Rock samples were subjected for visual observation using hand lens and all the samples were analyzed using XRD instrument to identify their REE mineralogy. Based on the results obtained, monazite, apatite, allanite, bastnaesite and loparite are the major RE minerals found. Moreover, Massenna zircon granite has the highest potential of REEs particularly LREEs and Y, compared to other pegmatites. REEs present in the in-situ soil and sediment samples indicate that, REEs have been transported through weathering and erosion processes of the zircon granite, thus proving the REE potential in the source rock. Therefore, this research clearly provides insights of REE potential in the pegmatite bodies in Sri Lanka and more REE explorations need to be carried out in these prospects.

Keywords: Balangoda, Pegmatite, Rare Earth Bearing Minerals, Sri Lanka, XRD Analysis

REE Potential in Carbonatite Deposits: A Case Study of Eppawala Carbonatite

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Rare earth elements (REEs) are currently the most strategic elements in the world due to their significance in the diversified technological applications. Currently, a total of 478 million tonnes of REE resources is disseminated across the world, which is dominated by the carbonatite deposits. The most common REE-bearing minerals found in carbonatites are bastnaesite, apatite, monazite, allanite and parisite. In this regard, the Eppawala carbonatite in Sri Lanka could be considered as a potential REE resource. The Eppawala carbonatite occurs in high-grade meta-sedimentary and igneous rocks of the Precambrian Wanni Complex as massive intrusions. In the Eppawala carbonatite, bed rock is mainly composed of calcite (~90%), dolomite (5-9%) and magnesite (accessory carbonate mineral), whereas chloro-fluor-hydroxyapatite, fluorapatite and carbonate-fluorapatite are present in a secondarily developed phosphate-rich regolith. The Eppawala carbonatite is enriched of REEs (~291-1962 ppm) with higher concentrations of LREEs. However, despite these evidences, only a few REE prospecting studies have been carried out in the Eppawala carbonatite. Therefore, detailed REE prospecting studies are recommended to discover the full potential of this prospect, followed by development of suitable REE extraction processes.

Keywords: Carbonatites, Eppawala carbonatite, Rare earth elements (REEs), Rare earth minerals, Sri Lanka

Acknowledgment: AHEAD/DOR/6026-LK/8743-LK

Abstracts of ISERME 2020

Session III

Mineral Processing and Environmental Engineering

Abstracts of ISERME 2020

Remote Sensing Analysis of Urban Heat Island Effect in Colombo City from 2001-2019

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Urban Heat Island (UHI) is a region, where the temperature is several degrees higher than surrounding rural areas in a metropolitan area. In the context of UHI phenomenon, Land Surface Temperature (LST) was estimated using Landsat satellite images covering Colombo city, which is one of the main commercial metropolitan cities in South Asia. Results revealed that UHIs have expanded into northern, eastern and south eastern regions of Colombo city within the period 2001-2019. Rapid urbanization in the city led to significant changes of Land Cover. The correlation of Normalized Difference Built up Index (NDBI) and Normalized Difference Vegetation Index (NDVI) with LST were analysed and obtained negative correlation between NDVI & LST and positive correlation between NDBI & LST at four time period (2001,2009,2016 & 2019) indicating the vegetation can weaker the UHIs while built up land can strengthen the UHIs. The results of Albedo analysis show that the low albedo materials have more potential influence towards formation of UHI. Finally, according to the ecological evaluation of the city using Urban Thermal Field Variance Index (UTFVI), 27% of the area is experienced worst case of heat stresses due to high building density, low vegetation and low albedo surfaces, reminding that mitigation measures should be applied in future urban planning to uplift the quality of lives and environment.

Keywords: Albedo, LST, NDBI, NDVI, UTFVI

Feasibility of Extraction of Cerium dioxide (CeO₂) from Monazite at Pulmoddai

Rasanjalee PHAU, Delaksana S, Sampath MD, Dushyantha NP, Batapola NM, Dissanayake DMDOK and *Rohitha LPS

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Rare earth elements (REEs) are necessary components for a wide range of high technological applications, especially in green energy applications. Therefore, rare earth (RE) demand has shown an exponential growth over the past few decades (1985-2020) indicating a supply risk of REEs in the near future (fast forward to 2020). Among deposits discovered all over the world, placer deposits are considered as a valuable RE resource, particularly monazite placer deposits in India and Australia. In this context, the Pulmoddai mineral sand deposit in Sri Lanka is a significant RE resource, due to its high monazite concentration (1.38%). Its REE composition is more than 61%. Currently, only heavy minerals are separated and cerium rich monazite is discarded for many years. Therefore, the study is focused on finding the feasibility of extraction of CeO₂ from Pulmoddai monazite. The process was carried out under four stages, namely, removal of phosphate ions, removal of radioactive elements, purification and Rare Earth oxide (REO) preparation and selective separation of CeO2. The optimum concentration of alkaline solution is found as 80% (w/v)/ 20M NaOH. Alkaline digestion was carried out for 4hrs at 150 °C by adding 25 ml of NaOH to 25 g of monazite, followed by acid leaching with 50 ml of 60% (w/v) HCl at 90 °C with 1atm pressure for 1hr. Concentration of 20 g/L (0.22M) oxalic acid should be added to the RE chloride mixture until the complete precipitation of RE oxalates. Purified REO was obtained by calcination at 900 °C for 2hrs using RE oxalate precipitated. Purified REO was used to recover CeO₂ by subjecting to selective precipitation. Selective precipitation of CeO₂ was carried out using solid form of KMnO₄ and (15wt%) Na₂CO₃ solution by maintaining average pH value 4 with the manual addition of Na_2CO_3 solution ([15 grams / 100 L]/0.001M).

Keywords: Acid leaching, Alkali leaching, Calcination, Rare Earth Element, Selective precipitation.

Monitoring Beach Profile Changes and Modelling Nourishment Scenarios for Ratmalana Beach

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Sri Lanka is an island nation endowed with a wide range of coastal resources, including scenic beaches and beach mineral deposits. According to the literature, it is evident that coastal regions greatly contribute to the Gross Domestic Product of the country. However, coastal erosion is a major issue related to the beaches in Sri Lanka. In this regard, the location of Ratmalana beach is critically important as a potential tourism destination due to its proximity to the capital city of the country and the accessibility to a coastal railway station. To develop a beach as a tourist destination, it is of utmost importance to monitor the beach profile changes and find out the remedial measures for erosion prevention. To maintain the scenic view, beach nourishment is preferred for this venue. In this research, Ratmalana beach was regularly monitored and a numerical model was built by utilizing the public domain of XBeach in order to model the hydrodynamics in the area. Ultimately, two nourishment scenarios were modelled, and the optimum nourishment scenario is determined for the area. Beach profile monitoring and calculated sand budget indicates that there is significant erosion during the stormy weather season. Based on grain size analysis, Ratmalana beach has a broad grain size distribution. According to the modelled nourishment scenarios, profile nourishment has shown better performance.

Keywords: Numerical Modelling, Sand Budget, Tourist Destination, XBeach

Heavy Mineral Sands in Kirinda Area, Deposit Characteristics and Extraction Potential

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In mineral processing industry some percentage of resources left uselessly without being used in production. This is mainly due to the recovery cost of low-grade resources being higher than the economic value of the valuable mineral. Also, the methods of recovering them are too complex and these low-grade minerals cannot be used as raw materials to manufacture products.

By studying literature facts and industrial surveying that are related to mineral processing, in Sri Lankan context Pulmoddai deposit is the best beach heavy mineral resource which has ever found. Processing of that resource is feasible and highly economical due to its high concentration of valuable minerals. Concentrations of deposits like Kirinda are considerably low compared to Pulmoddai. But there is a possibility of containing high concentrations of valuable minerals within the small percentage of heavy mineral content in Kirinda beach sands.

Attempt through this study is to find out whether there is an extractable amount of heavy minerals contain within beach sand of Kirinda area and to find out a method to separate them economically.

Keywords: Beach sand, Gravity separation, Harbour, Ilmenite, Mineral processing

Selective Precipitation of Lanthanum and Neodymium oxides from Pulmoddai monazite, Sri Lanka

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Pulmoddai is the largest known deposit of heavy mineral sand in Sri Lanka. Because of the high concentration of Rare earth elements (REEs), Pulmoddai deposit's value is considered to be economically enhanced by extracting REEs. Lanka mineral sand produces 100-120 tons of monazite per year and it is currently treated as a waste. This crude monazite consists of Light rare earth elements and the radioactive element of Thorium (Th) and Uranium (U). The objective of this work was to develop a systematic scientific process to separate phosphate ion, radioactive elements and Neodymium and Lanthanum oxides from this deposit. In today's age, many extraction methods are used to extract the REEs. But it does have some limitations in Sri Lankan context. Hence, this study was carried out using a process of selective precipitation. Dephosphorization was carried out in alkaline media with different Sodium hydroxide concentrations of 50, 60, 70, 80% (w/v) at temperature 150 °C for 4 hours at 1 atm. The optimum dephosphorization was observed in 80% (w/v) of NaOH concentration. Digested rare earth hydroxides were neutralized by using 60% (w/v) of hydrochloric acid at temperature 90 °C for 1 hour at 1atm. 2% (w/v) of oxalic acid was used in the rare earth chloride solution for removing impurities. Rare earth oxides (REOs) were obtained at 900 °C using calcination of rare earth oxalates. RE oxides were dissolved using 80% (w/v) HCL. In selective precipitation, 15%(w/v) NH₄OH with KMnO₄ were added to isolate Lanthanum and Neodymium hydroxides from RE chloride solution at controlled pH 4. Once again, 15% (w/v) NH₄OH with KMnO₄ at regulated pH 8.5 was applied to separate Lanthanum and Neodymium hydroxides. To obtain their oxide forms, these two hydroxides were calcinated at 900 °C.

Keywords: Acid Leaching Alkaline digestion, Rare Earth Oxides, Oxalic acid

Adaptation to Future Flooding in a Lowland City, A case of Jakarta City

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Hydrological model and 2D non-uniform flow model are applied to Chilliun River Baisn including Jakarta City, capital of Indonesia to evaluate countermeasures as the adaptation in the future. For the future projection, rainfall data was made using 8 GCMs (General Circular Model: CNRM-CM5, IPSL-CM5A-LR, GFDL-ESM2M, MPI-ESM-LR, MIROC-ESM-CHEM, CanESM2, CSIRO-Mk3-6-0, HadGEM2-AO) with statistic downscaling and bias correction. Future scenarios were prepared for land use change, land subsidence and 3 RCPs (Representative Concentration Pathway: 2.6, 4.5, 8.5). Structural and non-structural countermeasures were evaluated as the adaptation for flooding. Structural countermeasures are a recharge pond, recharge wells, Garuda Project, and green infrastructure, and non-structural countermeasures are landuse control and land subsidence control. Only landuse change to 2050 increases 99% flood damage cost (almost double from current situation) and only land subsidence to 2050 increase 95% one. The combination of land use change and land subsidence makes 226% higher damage cost in 2050 than current one. This calculation shows the emphasis of both influences. Future extreme rainfall in the period from 2051 to 2100 increases 1.2 time to present rainfall. Heavier downpour makes higher damage cost by flooding. Only future rainfall increases 77% and 99% on mean flood damage (annual expected damage costs) in around 2050 and 2100, respectively. However, the range of damage cost by each GCM is large and some models show the decrease of damage cost in 2050. The combination of land use, land subsidence and climate change shows 5 times damage cost to current situation. In the options of adaptation for future flooding, the best option is land use control, green infrastructure, retention pond, and recharge wells for damage reduction ratio, benefit, benefit-cost, and benefit/cost, respectively.

Keywords: GCMs, Landuse control, Land subsidence, RCPs, Retention pond

Estimation of the Number of SARS-CoV-2 Infections in a Sewershed Based on Wastewater-based Epidemiology

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The importance of wastewater-based epidemiology (WBE) has recently gained global attention, since scientific reports indicate that the concentration of viruses in wastewater is closely linked to the number of patients in a sewershed. It is thus expected to be a powerful tool in the current COVID-19 worldwide pandemic for epidemic surveillance and decision-making supporting. In this study, we explored the possibility of developing a mathematical model for estimating the number of patients infected by SARS- CoV-2 in a sewershed based on wastewater-based epidemiology. The model is largely based on SIR model, a widely applied mathematical model for computing and predicting the epidemiological dynamic in a setting of contagious illness. By taking aspects such as population size, sewage network layout, environmental conditions, and virus detection efficiency into consideration, the number of patients in a sewershed required for successful detection can be determined.



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