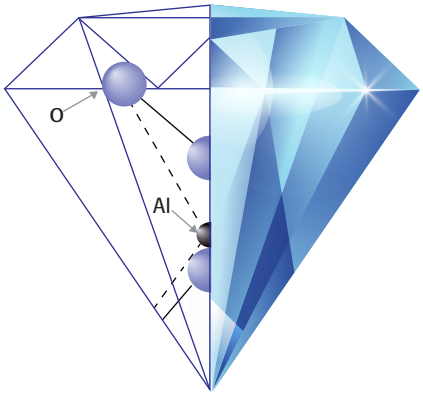

GJRTI INTERNATIONAL RESEARCH SYMPOSIUM 2024

02nd August 2024 | BMICH, Colombo, Sri Lanka

PROCEEDINGS

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(Ministry of Industries)

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"GEARING THE GEM AND JEWELLERY INDUSTRY TOWARDS ECONOMIC GROWTH"

02nd August 2024
BMICH, Colombo, Sri Lanka

ABSTRACT

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Mr. W.G.C.N. Wewegedara
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GJRTI International Research Symposium 2024

02nd August 2024

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Rapporteur : Dr. Padmakumara Jayasinghe

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GJRTI- 2024-01

Discovery and Characterization of High-Silica Sinhalite ($MgAlBO_4$) in Kiriella, Sri Lanka

I.K.M.S.C.K. Illangasinghe[1*], H.M.M. Kulasooriya[2], Y. Zhang[3], M. Chen[3], L.V. Ranaweera[4], R.M.N.P.K.Jayasinghe[1]

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Sinhalite ($MgAlBO_4$) is a non-silicate mineral with an olivine structure. Its structure comprises M-1 and M-2 octahedral sites occupied by small, highly electronegative Al^{3+} cations and less electronegative Mg^{2+} cations, respectively, and a T tetrahedral site occupied by B atoms. Normally, Fe^{2+} substitutes for Mg^{2+} at the M-2 site only. Some previous studies suggest that Si^{4+} substitution in the sinhalite structure is impossible. Meanwhile, sinhalite samples have been found in Kiriella, Sri Lanka, with an abnormal silica content. Chemical analysis of these sinhalite using high-precision spectroscopic and analytical techniques are discussed. For the analysis, four sinhalite samples were collected from gem pits in the Kiriella area and sliced by polishing both sides. The physical gemmological properties, as well as Raman and Fourier transform infrared spectroscopic analyses, were performed on the sliced samples. In addition, detailed chemical analysis was conducted using the Laser Ablation Inductively Coupled Plasma Mass Spectrometry technique. Major oxide weight percentages of Al_2O_3, MgO, B_2O_3, FeO, and SiO_2 ranged from 39.7-40.4%, 32.2-33.1%, 25.2-25.8%, 0.75-1.70%, and 0.43-0.53%, respectively. Physical and gemological properties were compatible with those of sinhalite. Raman spectroscopy clearly depicted identical Raman peaks corresponding to the translational and stretching bonds of BO_4 and MgO, confirming that these samples are sinhalite. The average chemical composition of the analysed samples is $Mg_{1.04}Fe_{0.02}Al_{1.01}Si_{0.02}B_{0.94}O_4$. The present data clearly show that the SiO_2 content is comparatively high in these newly found sinhalites with elevated MgO and depleted B_2O_3 contents. This observation could be evidence for the existence of sinhalite solid solution with silicate olivine group through couple substitution of Al + B = Mg + Si, as previously inferred. Further, boron has been recorded in the T site of olivine-type forsterite in Jilin Province, China, where boron and hydrogen couple substitute for silicon, producing a strong O-H band at 3696 cm^{-1}. Thus, Si might be substituting B at the T site of sinhalite. The comparatively depleted boron content and weak absorption band at 3693 cm^{-1} of the sinhalite supports this substitution hypothesis. Analysis of detailed unit cell parameters of this new sinhalite variety is underway.

Key Words: Sinhalite, Silicon in Sinhalite, LA-ICP-MS, Sri Lankan Sinhalite

GJRTI- 2024-02

Tracing Gold in Sri Lankan Stream Sediments: Geochemical insights from the Getahathi Oya

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Despite Sri Lanka not being widely recognized for its gold production, some studies report the presence of gold rushes associated with stream sediments. Sharing a similar Gondwana geotectonic background with gold-rich countries like Madagascar, South Africa, and Mozambique, Sri Lanka also possesses favorable conditions for gold occurrence, similar to its well-known gemstone deposits. Present even, local inhabitants near the Walawe, Kelani, Kalu, Gin, and Nilwala rivers continue to pan for gold, often yielding approximately 0.4 grams of gold per day from stream sediments. Therefore, following the gold rush in Kumarimulla on the Kelani River in 2014, this research delved into the geochemistry in the stream sediments of the Gatahathi Oya, which is a head ward stream of the Kelani River catchment area. Fifteen sediment samples were collected along the Gatahathi Oya and analyzed using X-ray fluorescence spectroscopy. The results indicate higher gold concentrations in regions where well-known Getaheththa gem pockets are reported along the Gatahathi Oya (Avg. 15.6 $\pm$ 0.01 ppm) than in the Walawe Ganga (Avg. 4.8 $\pm$ 0.01 ppm). Geologically, the Gatahathi Oya traverses following a northwest-trending shear zone, consistent with the locations of gem pockets. Although the stream catchment is underlain by granulite rocks of the Highland Complex, the precise source of the gold was not identified in the field. Hence, this preliminary study highlights the need for further research to establish the correlation between regional geology, structural features, and gem pocket occurrences concerning the higher gold concentrations found in the stream sediments of the area.

Key Words: Geochemistry, Gold, Getaheththa Gem Pockets

GJRTI- 2024-03

Potential Detection Method for Gamma-irradiated Rubies and Pink Sapphires using UV-Visible and Infrared Absorption Spectroscopy

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One of the current issue in the ruby and sapphire industry is the detection of gamma-irradiated rubies and sapphires in the market. Consequently, gemological laboratories worldwide are struggling to introduce effective detection methods for these treated gemstones. There is an urgent need to introduce a reliable method to detect gamma-irradiated sapphires; otherwise, the ruby and sapphire industry could face significant challenges. Therefore, in this research, we aim to introduce a detection method for irradiated sapphires based on the infrared absorption spectrum. Twelve natural, untreated pink sapphires with a blue tint from Madagascar were selected for the study. All samples were sliced and polished on both sides parallel to the optical axis. The samples were then analyzed using UV-visible and FTIR spectroscopy before and after gamma irradiation. After the initial analysis, all samples were subjected to gamma irradiation. The irradiation process was conducted using a gamma cell, with each sample carefully positioned near the center to ensure uniform radiation exposure. Each sample was exposed to a dose of 150 KGy. The blue color of all samples was reduced or completely removed after irradiation. Many samples exhibited broad troughs around 400-460 nm and 500-550 nm in the UV-Vis spectrum after irradiation, attributed to the presence of Cr^{3+} transition metal ions, which impart a pink hue to the gemstones. The peak at 475 nm is identified as a trapped hole near the Fe^{3+} or Cr^{3+} ions, indicating that irradiation creates a new trapped hole in the lattice. The FTIR results showed that absorption peaks near 1000 cm^{-1} narrowed after irradiation. Therefore, there is significant potential to detect gamma-irradiated pink and ruby sapphires based on UV-visible absorption and FTIR spectroscopy. However, further studies are recommended.

Key Words: Gamma-irradiation, Irradiated Sapphire, Pink Sapphire, FTIR

GJRTI- 2024-04

Discriminating Synthetic Rubies from Natural Rubies using FTIR Spectroscopy: Identifying Key Spectral Characteristics

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Ruby is a type of corundum, mainly made up of aluminium of aluminum oxide (Al_2O_3), known for its vibrant pinkish-red to blood-red color, which is due to the presence of trace amounts of chromium (Cr^{3+}) impurities acting as the coloring agent within its crystal structure. Synthetic rubies are gemstones manufactured in laboratories and created using regulated procedures to resemble natural rubies' chemical makeup and crystal structure. Flux-grown, hydrothermal, and Verneuil-created rubies are some synthetic types. In the Verneuil process, powdered aluminum oxide is melted and crystallized into synthetic corundum, as highlighted in this research. Under this, we will identify specific characteristics of FTIR (Fourier Transform Infrared Spectroscopy) spectrums in synthetic Verneuil rubies that vary with natural ones. This method is crucial for rubies that do not have diagnostic inclusions or growth features, since such stones are difficult to identify using classical gem testing methods. About 20 ruby samples gained in the laboratory were collected and the samples were separated into three groups, the samples with inclusions belong to the natural corundums, the samples with inclusion belong to the synthetic Verneuil rubies like curved striations and gas bubbles, and finally, the stones that do not have any internal inclusions. Then, the samples were analyzed using the 532 nm wavelength setting of the Gemmo FTIR™ instrument. Then several peaks were identified in wavenumbers, 3183 cm^{-1}, 3227 cm^{-1}, 3304 cm^{-1} in some samples. Then most of the separated synthetic samples show a much longer 3227 cm^{-1} peak. When analyzing too cleaned samples using the FTIR spectroscope, most show a much longer 3227 cm^{-1} peak compared to other synthetic gem samples. Furthermore, 254 nm short wave UV light was used to confirm those samples as synthetic. This confirmed that all the samples with the more longer 3227 cm^{-1} peak were synthetic ruby samples. Thus, this research concludes that if a ruby gemstone hasn't any inclusion and shows a much longer 3227 cm^{-1} peak in the Gemmo FTIR, the Gemstone is a synthetic stone.

Key Words: FTIR Spectroscopy, Infrared Absorption, Synthetic Rubies, Verneuil Process

GJRTI- 2024-05

Enhancing the Clarity of White Sapphires by Filling Fractures

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This study focuses on enhancing the clarity of white sapphires of Sri Lanka by filling fractures with glycerin under controlled conditions. Glycerin was selected as the filling material for its transparency and high boiling point of 290 °C, despite its lower refractive index in comparison to sapphires. To mitigate this difference, sulfur was dissolved in glycerin to elevate its refractive index, aligning it more closely with the refractive index of sapphires, which is approximately 1.76.The gemstones were initially cleaned using aqua regia and documented in their untreated state through microscopic observation. Subsequently, the fractures within the gems were filled with glycerin using an oil filling machine capable of creating a vacuum environment reaching pressures up to 6 kbar and temperatures up to 110 °C. Three trials were conducted at varying temperatures and durations: 70°C for 8 hours, 90°C for 18 hours, and 90°C for 23.5 hours, utilizing both cut and rough gemstones. The evaluation involved detailed microscopic examination using gemological techniques. The study demonstrated that glycerin effectively filled the fractures, improving visual clarity and potentially increasing the market value of the treated gems. No significant refractive index mismatches were detected between glycerin and the gems, confirming the suitability of glycerin as a fracture-filling material for enhancing gem quality. This research presents a promising method for enhancing the appearance and commercial viability of fractured gemstones, contributing to the advancement of gem treatment methodologies in the industry.

Key Words: Fracture fillings, Refractive Index, Glycerin, Sapphires

GJRTI- 2024-06

Enhancing the Beauty of Purple Geuda Spinel from Sri Lanka through Heat Treatment

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Spinel is a well-known gem in the international gem trade. Various types of spinel are frequently found in Sri Lanka, though most are of low gem quality. Over the past decade, gem traders have attempted to improve the color and clarity of these low-quality spinels, but these efforts have not yet been successful. In this research, we aim to introduce a method for enhancing the color and clarity of purple geuda spinel to a desirable level through heat treatment. Seven spinel samples were collected from the Ratnapura gem market and polished on both parallel sides. Before treatment, each sample underwent analysis including GIA color grading, microscopic observation, and Raman spectroscopy. The samples were then heat-treated at 900, 1000, and 1200 °C for a soaking time of 2 hours. After each heating stage, the analyses were repeated. Samples improved up to the desirable level after the treatment except for a violet-blue sample. Microscopical images show fine inclusion particles are dissolved, while inclusion needles are partially dissolved. Therefore, to dissolve rutile needles requires a higher temperature than 1200 °C. The resulting Raman peak of unheated samples are shown at 311, 407, 665, and 763 cm^{-1} corresponding to Mg jumping at the tetrahedral, Al-O bending vibration, stretching of Mg-O, stretching of Mg-O, and Mg bending vibration respectively. After the heat treatment peak at 407 cm^{-1} all samples broadened, and the peak intensity of the above peaks was reduced. The results revealed that geuda-like fine particles are dissolved at 1200 °C while needle-like particles are partially dissolved. Therefore, to complete dissolving of these particles needs to be given a higher temperature than 1200 °C. Furthermore, Raman spectrum changes suggested disclosing the heat-treated spinel. Finely, this study concluded there is great potential to improve the beauty of the geuda spinal in Sri Lanka.

Key Words: Spinel Heat Treatment, Geuda Spinel, Raman Spectrum

GJRTI- 2024-07

Occupational Injuries and Associated Factors among Tunnel gem-miners in Nivitigala, Sri Lanka

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Sri Lanka often referred to as "Gem Island", has a rich history of the gemstone industry. Despite the massive contribution towards the country's economy, this industry grapples with the noteworthy challenge of occupational injuries. The evidence on occupational safety in the gem industry is scarce. Therefore, this study aimed to assess the socio-demographic characteristics, occupational injuries and their associated factors among the tunnel gem miners in Nivithigala, Sri Lanka. A descriptive cross-sectional study was carried out in Nivithigala, Sri Lanka from March to September, 2023. Cluster sampling method was used to select 110 tunnel gem miners aged 18-70 years, without severe co-morbidities with work experience of more than one year at tunnel gem mines. An interviewer-administered questionnaire was used to collect socio-demographic, behavioural, work-related and occupational safety-related factors and occupational injury-related data which were analyzed using SPSS version 26. Associations were assessed using the chi-squared test. The response rate was 100% (n=110). More than half of tunnel gem miners (52.7%, n=57) experienced occupational injuries past 6 months, mainly due to machines/tools (n=79, 73.8%). Most injuries were abrasions (n=65, 60.8%) commonly affecting lower limbs (n=68, 63.7%). Occupational injuries were significantly associated with working more than 8 hours per day ($X^2=4.384$, $p=0.036$, $p<0.05$), experiencing excessive heat/ cold during underground work ($X^2=8.603$, $p=0.003$, $p<0.05$) and paucity of identification and addressing of safety issues in the workplace ($X^2=4.982$, $p=0.038$, $p<0.05$), but not associated with mining experience ($X^2=1.658$, $p=0.198$, $p>0$-05) and working under the influence of alcohol ($X^2=1.341$, $p=0.309$, $p>0.05$) or tobacco ($X^2=2.536$, $p=0.134$, $p>0.05$). The incidence of occupational injuries among employees is relatively high and often due to machine/tool mishandling and unfavourable work environments. Measures should be taken to reduce long working hours and extreme temperatures during underground work. Increasing the use of personal protective equipment remains a potential target for improving mineworkers' safety.

Key Words: Occupational Injuries, Tunnel, Gem Mining, Safety, Personal Protective Equipment

GJRTI- 2024-08

Examine the Undocumented Impacts of the Pearl Fishery Industry (15th-17th Centuries CE) in the Gulf of Mannar through Pinctada fucata Shell Morphometry Analysis and Species Composition in Shell Middens

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The Gulf of Mannar's (GoM) pearl fishery industry in Sri Lanka, dating back to at least the 5th century BCE, has been historically exploited for pearl oysters (Pinctada fucata). This study, with a historical ecology perspective, investigates the undocumented ecological impacts of this industry by analyzing pearl oyster shell middens dating from the 15th-17th centuries CE, based on ^{14}C AMS radiocarbon dating. Three 1×1 m test pits were excavated along the Mannar seaboard in selected middens at Keeri Beach at Mannar Island, Arippu Doric Bungalow, and Kondachchi. The Shannon Index of Diversity (H') and Margalef Richness Index (d1) were used to analyze diversity and richness, while shell morphometrics (Dorsoventral Length, Hinge Length, Heel Depth) were examined against pH measurements and fragmentation. Shell's heel depth was identified as the most reliable morphometric attribute for analysis. Statistical analysis included multivariate frequency testing and a one-sample Student's t-test, contextualized with historical records and ecological data. Each midden exhibited varying shell size distributions, indicating changes in exploitation patterns. Keeri Beach middens, potentially representing undisturbed pearl banks, contained larger oysters, suggesting a prolific and sustainable industry. Middens from Arippu and Kondachchi, dominated by smaller oysters, suggest overexploitation and less selective harvesting. The Renaissance-era shift in European demand from larger pearls to seed pearls may have contributed to the increased exploitation of younger oysters. The middens reveal the long-term ecological consequences of pearl harvesting, including evidence of overexploitation and habitat disturbance. The low species diversity (NTAXA=73) in these middens, compared to the extended taxonomic lists documented in the early 20th century, may be due to natural or human disturbances, including the pearl fishery. The absence of larger bycatch species raises questions about deliberate removal or other impacts. Our findings emphasize the interplay between ecological factors and industrial harvesting in shaping pearl oyster ecosystems. Integrating archaeological and historical data is crucial to understanding the impacts of industrial-scale resource exploitation on marine environments. As this is the first study to use shell morphometry and species diversity-richness to analyze the ecological impacts of the pearl fishery industry in any such context, further research is needed to quantify the long-term ecological effects of pearl oyster fisheries.

Key Words: Pearl Oyster, Shell midden, Gulf of Mannar, Industrial Exploitation, Shell Morphometrics, Historical Ecology

GJRTI- 2024-09

Ancient Gem Beads of Jethawanaya Bead Collection, Sri Lanka; An Ethnogeological Study

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Sri Lanka has a long distinguished history on gems around the world. Attention to the geological materials such as precious gem minerals has been known for prehistoric time. Jethawanaya archaeological site is a part of the world heritage site of Anuradhapura records some findings of gems as beads in the collection of artifacts found from the excavations in and around the Jethawanaya stupa. Those were physically investigated and examined by means of physical properties of mineral identification such as color, shape, clarity, hardness, cleavages, streak etc. According to those physical observations, it is found that the natural gem bead collection consists of gems such as Yellow sapphire, Blue sapphire and Geuda, Almandine Garnet, different types of Quartz and Chert varieties. Finding corundum family gems in the collection is quite interesting since they are the second hardest mineral in the world. Interestingly those had been pierced to make the bead hole but started from the both ends to meet at the middle. Unaligned hole clearly evidenced it and the technology of Piercing should still to be uncovered. Distinctively the corundum beads had not faceted as the others as faceted very nicely in different shapes, but just polished. This evidences the difficulty of finding the materials that are harder than corundum to facet sharply or lack of knowing of diamonds due to unavailability in Sri Lanka during the Anuradhapura period. Less frequency of finding those corundums in the collection might be reasoned by lack of knowledge on taming them as they wanted. It can also be interpreted as better knowing of the mineral hardness by the ancient people.

Key Words: Ancient Gem Beads, Jethawanaya, Corundum, Hardness, Piercing

GJRTI- 2024-10

Evaluation of Non-Mercury Methods for Gold Refining in the Small Scale Jewelry Sector: A comparative study

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The use of mercury in recovering gold from waste generated during the manufacturing process of gold jewelry raises significant health and environmental concerns within Sri Lanka's Small Scale Jewelry Sector (SSJS). Workers in the sector are at greater risk of exposure when there is a limited understanding of the adverse effects of mercury and inadequate safety precautions during its handling. Additionally, the disposal of mercury-laden tailings intensifies these environmental pollution concerns. This study aimed to identify environmentally friendly, non-mercury alternatives for gold separation. The aqua regia, modified borax, and hypochlorite methods were evaluated. The Aqua regia method yielded the highest gold separation rate at 82%, while the modified borax method had the lowest yield at 43%. However, the aqua regia method was associated with the emission of toxic NO_2 gas. Despite a slightly lower separation rate of 78.07% compared to aqua regia, the hypochlorite method was identified as the optimal choice in terms of environmental friendliness, health, and cost-effectiveness.

Key Words: Small Scale Jewellery Sector (SSJS), Mercury Pollution, Gold separation, Alternative Methods, Hypochlorite Technique

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Tourism Perception on the Sri Lankan Gem and Jewellery-related Tourism Industry

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The gem and jewellery industry in Sri Lanka is a cornerstone of the nation's tourism sector, attracting a global audience with its rich heritage and exquisite craftsmanship. This study investigates the foreign perception of gem and jewellery-based tourism in Sri Lanka, aiming to understand the industry's influence on tourist satisfaction and the country's image as a travel destination. The primary purpose of this research is to explore how international visitors perceive the quality, authenticity, and value of Sri Lankan gems and jewellery, and how these perceptions impact their overall tourism experience. A mixed-methods approach was employed, combining quantitative surveys and qualitative interviews. Surveys were distributed to a sample of 100 international tourists who visited gem and jewellery outlets across key cities, including Ratnapura, Colombo, Kandy, and Galle. In-depth interviews were conducted with 20 tourists to gain deeper insights into their personal experiences and perceptions. Data analysis involved statistical techniques using Excel and SPSS to interpret survey responses and thematic analysis for interview transcripts. The findings indicate that 85% of foreign tourists perceive the gem and jewellery industry positively, citing high quality and uniqueness. However, 30% expressed concerns about authenticity and pricing, suggesting a need for better regulation and transparent pricing strategies. Positive experiences in gem and jewellery tourism significantly enhance overall satisfaction and the likelihood of recommending Sri Lanka as a travel destination. In conclusion, the gem and jewellery industry plays a vital role in shaping foreign perceptions of Sri Lanka. Enhancing authenticity, improving customer service, and implementing fair pricing can further strengthen the industry's contribution to tourism, ensuring a sustainable and positive image for Sri Lanka on the global tourism map.

Key Words: Gem and Jewellery, Tourism, Foreign Perception, Sri Lanka, Tourist Satisfaction

GJRTI- 2024-12

Identification of Potential Gem Tourism Sites and their Geospatial Distribution in Ratnapura District, Sri Lanka; An AHP and GIS Approach

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Sri Lanka's rich history in gem mining presents a unique opportunity for developing gem tourism, a segment of the tourism industry. Hence a strategic approach is needed in addressing the expansion to gain an economic growth. Identifying the potential sites is required which can be merged with the national and local touristic sites and plans. Therefore the present study was conducted to identify the potential gem tourism sites in Rathnapura district, Sabaragamuwa province, Sri Lanka, based on Geographic information system (GIS) with the application of Analytic Hierarchy Process (AHP). The field investigations were carried out to collect the primary data on gem trading sites, mining sites, museums, shops, laboratories etc. in Rathnapura district to prepare a resource inventory. Based in the criteria such accommodation facility, accessibility and other amenities, the three most suitable potential sites were selected. In addition, world heritage sites, sanctuaries, national parks, archaeological and cultural landmarks, ecologically significant areas, and religious pilgrimage centers were included in the selection based on secondary sources as existing tourist places. Subsequently, ArcGIS Pro 3.3.1 was used to carry out the AHP calculations. Due to the facilitated integration of spatial data and weighted overlay calculation, the potential gem tourist sites have been circled on the suitability map. The results of the study indicated varying levels of suitability for gem tourism across different site clusters in the study area. Rathnapura, Pelmadulla, and Eheliyagoda were identified as highly suitable for gem tourism, with strong potentiality for attracting tourists. Kuruwita, Kiriella, Ayagama, Idangoda, Nivithigala, and Elapatha are found to be moderately suitable, whereas Imbulpe, Balangoda, Kolonna, and Pallewela are least suitable, indicating limited potential for gem tourism currently. Some clusters in the study area are deemed unsuitable for gem tourism. The identified gem tourism sites can be published as a digital story through the ArcGIS Story Maps platform, these findings can be effectively communicated to a wider audience, fostering interest and investment in gem tourism. The study also provides a GIS model for identifying potential of gem tourism sites, which can be utilized for further development, offering an approach to harnessing Sri Lanka's gem tourism for sustainable development.

Key Words: Gem Tourism, Suitability, Analytic Hierarchy Process, GIS

GJRTI- 2024-13

Momentousness of Sri Lankan Gem and Jewellery Industry on Burgeoning Sri Lankan Tourism

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From time immemorial Sri Lanka, captivated tourists with its variety of gems and exquisite jewellery. Ancient tourists who visited Sri Lanka corroborated that gems were exported from Sri Lanka. Island produces the best blue sapphires, which are highly sought after by persons ecumenically. Some tourists intrinsically arrive here mainly to acquire these gems. Others have the intention of learning, observing the source of gems, having an inclination to carry back a gem, an authentic piece of jewellery. Besides there are tourists who wish to expertise in the field of gemstones. But deprivation of an accoutred auditorium, gem museum and a gem library, exclude international tourist researchers from the country. The industry task implies creating value feasible for stakeholders unescorted by trade-offs. Thusly, the research formulates the research question, what are the accessible dimensions of gem and jewellery industry on burgeoning tourism? Objective of this research is to discuss the accessible dimensions of gem and jewellery industry on burgeoning tourism. Comportment of methodology is comparative research, which aims to make comparisons across two different countries. Traditional literature review on Thailand and Sri Lankan gem tourism is the method of data gathering. Traditional review remains in realm of general, flexible, serving myriads potential the project requires, capacitates creativity and illumine novelty into promulgated knowledge. Obedient with previous literature, tourists' appeal in Sri Lanakan industry is censorious to boost tourism. Thailand's gem researches allures tourists. Sri Lankan gem tours, lack the technical literacy. Tours apprising on varieties, occurrence, mining, value addition, furnished with undisputed impression are required. The in-house-short-term courses, workshops, provided by the Gem and Jewellery Research and Training Institute for tourists at a competitive fee is highly advantageous in developing gem tourism. Consequently, there is an urge for greater alignment amongst the Sri Lankan gem and jewellery industry to amalgamate with tourism industry to expand gem tourism which is a high potential of the country.

Key Words: Gems and Jewellery, Gem and Jewellery Industry, Gem Tourism, Sri Lanka, Tourism Industry

The Remedial Actions for the Problems Encountered by the Gem Industry in Ratnapura District

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Ratnapura, the heart of Sri Lanka's gem industry, includes diverse stakeholders such as miners, workers, and dealers, who significantly contribute to the local and national economy. However, the industry's sustainability, transparency, and inclusivity are questionable due to various issues. Persistent issues such as environmental degradation, workforce-related challenges, and social problems continue to plague the industry, with insufficient action from authorities to mitigate these concerns. These issues are also relevant to other gem-producing regions in Sri Lanka. This research comprehensively examines the entire gem industry chain in Ratnapura, from mining to trading. It critically evaluates the impact of different mining practices on the environment, financial distribution among stakeholders, and worker-related issues. Social concerns, including income disparity, gender inequality, and vague financial schemes, are scrutinised. Additionally, the study addresses misconceptions about insurance and various trading malpractices, such as the sale of synthetic and fake stones, illegal exports, and money laundering. Substantial evidence supports these findings, highlighting the need for effective interventions. The research proposes several potential remedies, including the adoption of new technologies to mitigate environmental damage and improve transparency. It also discusses the potential decline of the local mining industry, emphasising the importance of fostering the re-exportation of gems to sustain economic growth and support local livelihoods. Moreover, the study outlines the necessity for comprehensive regulatory reforms to address the identified issues. By proposing targeted solutions and encouraging the adoption of best practices, this research aims to pave the way for a more sustainable, transparent, and inclusive gem industry in Sri Lanka. The findings and recommendations of this study provide a good foundation for further research and policy development to enhance the industry's overall health, sustainability, and longevity.

Key Words: Ratnapura, Gem Mining, Gem Trading, Environmental Issues, Suspended Sediment Concentration, labour Issues, Insurance, Social Issues, Trading Malpractices, Value Addition

GJRTI- 2024-15

Application of Step Frequency Ground Penetration Radar (SFGPR) for Detecting Underground Tunnel Gem Mining in Ratnapura, Sri Lanka: A Preliminary Study

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The Ratnapura area in Sri Lanka boasts some of the world's most valuable gemstones, concealed within ancient sediment archives as secondary deposits. This hidden treasure has encouraged underground tunnel mining, some of this mine, involving the encroachment on roads, buildings, and uncharted lands beneath the earth's surface. Such unauthorized activities have led to frequent complaints reaching the National Gem and Jewellery Authority, the regulatory body overseeing this sector. Addressing these grievances has proven challenging due to the inherent difficulty in physically accessing these subterranean mines. This research seeks to explore a modern solution to this persistent problem: Step Frequency Ground Penetration Radar (SFGPR). By employing this cutting-edge technology, we aim to evaluate its effectiveness in uncovering illegal underground tunnel mines. A well-known tunnel mine near a culvert in Godawela, Hungamuwa, Ratnapura was selected to facilitate this investigation. A state-of-the-art "Field-Fox" GPR instrument was employed to conduct SFGPR survey across the tunnel mine and the adjacent culvert. The resulting SFGPR profiles were meticulously analyzed, indicating significant anomaly in underground soil layer discontinuity at a depth of 11 m, precisely corresponding to the location of the mine and culvert. The height and width of the anomaly were 1.5 m and 1.8 m, respectively. These findings not only validate the potential of GPR in detecting illegal tunnel mining activities, but also underscore its utility as a vital tool for regulatory authorities in preserving the integrity of the gemstone industry in Ratnapura. This research presents a promising step towards curbing the illegal extraction of precious gemstones, safeguarding the region's natural resources, and ensuring sustainable practices in the gem and jewellery sector.

Key Words: Rathnapura, Gem Industry, Tunnel Mining, Ground Penetration Radar, SFGPR Profiles

Comparative Analysis of Untreated and Heat-Treated Sapphires from Different Localities within Sri Lanka by FT-IR Spectroscopy

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Fourier Transform Infrared Spectroscopy (FT-IR spectroscopy) has become an essential technique in distinguishing between heated and unheated sapphires, identifying glass-filled sapphires and beryllium-treated sapphires in recent decades. Most of the naturally occurring rubies and sapphires contain trapped water in their structure. Infrared spectra can reveal this presence, typically indicated by a minor peak at 3310 cm^{-1} corresponding to the O-H stretching mode of water. Additionally, peaks could be observed at 3309 and 3161 cm^{-1} for the samples with pegmatitic origin. Further, it has revealed the introduction of intense O-H bands after heat treatment and the elimination of O-H peaks after high-heat beryllium treatment. The current study focused on comparing and contrasting known heated and untreated sapphires sourced from various locations in Sri Lanka, utilizing FT-IR spectroscopy. Twenty five cut and polished natural untreated and heat-treated sapphire samples were collected from Pelmadulla, Ratnapura, Embilipitiya, Pallebedda, Bellana, Okkampitiya, Kiriella and Eheliyagoda areas. FT-IR spectra were acquired using Gemmo model FT-IR spectrometer within the range of 400 to 7000 cm^{-1}. Untreated sapphires from Embilipitiya, Eheliyagoda and Kiriella localities exhibited a peak at 3308 cm^{-1}, likely associated with O-H groups. Conversely, untreated sapphires from Ratnapura, Bellana, Okkampitiya and Pelmadulla did not show any peak at 3308 cm^{-1}. Untreated pink and yellow sapphires from Pelmadulla and Pallebadda exhibited a peak at 3149 cm^{-1}, indicative of O-H group presence. Heat-treated sapphires from Okkampitiya, Pelmadulla, Ratnapura and Pallebedda have given a peak at 3308 cm^{-1}, however it was not visible in the samples from Embilipitiya. It is plausible to suggest sapphires that have displayed an O-H peak initially and disappeared following heat treatment may have an igneous origin, whereas sapphires that acquired O-H groups after heat treatment may have a metamorphic origin. Additional studies are recommended for further clarification.

Key Words: Natural Sapphires, Heat-treated Sapphires, O-H peak, FT-IR

Investigating color variation in Sri Lankan blue sapphires using Raman spectroscopy analysis

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The color of sapphire plays a crucial role in determining its value and market appeal. While sapphires are naturally colorless in their purest form, they acquire their diverse colors due to impurities and specific atomic interactions. Blue sapphires derive its color from a complex interplay of Fe and Ti ions within its crystal structure through intervalence charge transfer. The intensity and shade of blue in these gemstones depend on the concentration of these trace elements and the strength of their chemical interactions. This variation in color contributes to different grades of blue sapphires, which are valued differently in the marketplace. Therefore, studying the factors influencing sapphire coloration is crucial for gemologists. The current study aims to explore any correlation between Raman peaks and the color of Sri Lankan blue sapphire. Sixteen natural, unheated blue sapphires from Sri Lanka were examined in this investigation using Gemmo Raman532 to acquire Raman spectra. The samples exhibit typical Raman shifts of corundum at 369, 410, 437, 565, 633, and 739 cm^{-1}. The [Al_2O_3] group is responsible for the bending vibrations at 369, 410, and 437 cm^{-1}, whereas the stretching vibrations at 565, 633, and 739 cm^{-1} are caused by the group. The study revealed a significant correlation between the color of blue sapphire and four specific Raman peaks.

Key Words: Colour Centers, Raman Peaks, Blue Sapphire

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