PROCEEDINGS OF
1st GJRTI ANNUAL SYMPOSIUM

"TOWARDS THE SUSTAINABLE GEM AND JEWELLERY INDUSTRY"

2023
GJRTI SYMPOSIUM

25th October 2023
BMICH, Colombo 07, Sri Lanka

Co - Editors

Mr. R.M.N.P.K. Jayasinghe
Mr. I.K.M.S.C.K. Illangasinghe
Mrs. S. Wijewardane

GJRTI

GEM AND JEWELLERY RESEARCH AND TRAINING INSTITUTE
(Ministry of industries)

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Proceedings of the 1st GJRTI Annual Symposium

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ABSTRACTS

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Published by:

Gem and Jewellery Research
and Training Institute

No: 73/5/A, "Ruwan Sewana",
Weliwita, Kaduwela, Sri Lanka

Website : www.gjrti.gov.lk
Facebook Page : www.facebook.com/gjrtigov

ISSN: 3021- 6656

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1st GJRTI Annual Symposium Technical Session

25th October 2023

Technical Session I

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Rapporteur : Dr. L.V. Ranaweera

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1st GJRTI Annual Symposium Technical Session

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GJRTI-2023-01

Waste-to-Resource Approach to Recover Rare Earth Elements (REEs) from the Gem Mining Waste of Sri Lanka: A Case Study

G.G.I.U. Senarathna[1*], N.P. Dushyantha[1], N.P. Rathnayake[2], H.M.R. Premasiri[2], A.M.K.B. Abeysinghe[2], A.S. Rathnayake[1]

[1]*Department of Applied Earth Sciences, Faculty of Applied Sciences, Uva Wellassa University, Passaara Road, Badulla 90000, Sri Lanka*
[2]*Department of Earth Resources Engineering, Faculty of Engineering, University of Moratuwa, Moratuwa 10400, Sri Lanka*
**Corresponding Author:* hashansenarathna9@gmail.com

Sri Lanka is endowed with abundant gem resources, and gem mining operations are widespread across diverse regions of the country. However, only the valuable gemstones are collected, while the remaining fraction containing numerous heavy minerals is discarded as waste. Consequently, the gem mining industry generates substantial waste, primarily utilized for backfilling purposes. In order to assess the value recovery from this waste stream, this study was undertaken on gem mining waste sourced from a gem pit in the Kalutara region, particularly in relation to Rare Earth Elements (REEs). After the analysis of 20 samples in an inductively coupled plasma–mass spectrophotometer, it was determined that the gem-bearing alluvial layer contained a Rare Earth Oxide (REO) percentage of 0.3 w/w%. It was then easily upgraded up to 3.0 w/w% (light REEs = 94%) by wet sieving and subsequent density separation via a shaking table. The separation process showed promising results as the concentrate yielded 37% with a Total Rare Earth Oxide (TREO) grade of 3.01 and a total REE recovery of 74%. REE-bearing minerals such as monazite and xenotime were identified as the main REE carriers in the concentrate through x-ray diffraction analysis. Thus, the concentrates of gem mine tailings with REE-bearing minerals could be a secondary source for Light Rare Earth Elements (LREEs), where wet sieving and Wilfley shaking table separation have become promising upgrading methods for REEs. Given these findings, it is imperative to conduct a comprehensive exploration to assess the REE potential within gem mining waste across the country. Subsequently, value recovery processes should be developed to economically extract REEs and other critical metals. Furthermore, detailed research studies, encompassing other gem mines in Sri Lanka, are necessary to implement circular economic principles to maintain the sustainability of the gem mining of Sri Lanka.

Key Words: Value Recovery, Rare Earth Oxide, Wilfley Shaking Table, Wet Sieving, Density Separation

GJRTI-2023-02

Antiquity of Usage of Minerals and Metals in Sri Lanka: Socio-Economic Aspect

Chulani Rambukwella[1*]

[1]*Department of Archaeology, University of Peradeniya, Peradeniya, Sri Lanka.*
[*]*Corresponding Author:* rambukc@gmail.com

Sri Lanka, named Ratnadvīpa – the Island of precious stones, has an unbroken historical sequence of human habitations from the Prehistoric up to the modern era where minerals and metals as well as mining and metallurgy played a major role in history. The antiquity of the use of rock and minerals in Sri Lanka dates back to the beginning of human settlements, evidently to 125,000 BP and possibly to 500,000 BP. The objective of this study is to find out the nature of the use of minerals and metals in ancient Sri Lanka to identify the associated socio-economic and techno-cultural framework. To survey this archeological and literary data will be used. Among them explorations and excavations data, inscriptions, megalithic burial findings, art and architecture, and primary historical sources such as Mahavamsa and Chulavamsa and other documents are prominent. Quartz, chert, chalcedony, and miscellaneous materials like red ochre, graphite, mica, and pumice stones have been found since prehistoric times. The smearing of red ochre on the frontal bone in Prehistoric deposits of Ravana Ella cave and on human remains of Fa Hien cave clearly evidenced the use of minerals for ornamental cum ritualistic purposes. After 1000 BC, the usage of minerals and metallic and non-metallic resources in Sri Lanka seems to have increased qualitatively and quantitatively in different historical phases. The final results of this study will be the identification of gems, other rock and minerals, and metal resources scattered throughout the country to ascertain to what extent the ancient practices of those resources can be used for sustainable socio-economic development in Sri Lanka.

Key Words: *Gem, Mineral, Sri Lanka, Socio-economic, Archaeology*

GJRTI-2023-03

Computer-Aided Gemstone Valuation System

R.M.N.P.K. Jayasinghe[1*], S. Sutharshan[1], I. Samaradasa[1], Herbert Ranaweera[1,2]

[1]*Gem and Jewellery Research and Training Institute, Welivita, Kaduwela.*
[2]*Herbert Ranaweera – Manik Thaksalawa, No.10/2/A, 2nd Floor, Demuwawatha, Ratnapura.*
[*]*Corresponding Author:* naleenlk@hotmail.com

Over the past decades, people in the gemstone industry have applied their experience and knowledge gained for generations to categorise and make a valuation by examining the gemstone using the naked eye and a few tools. This method is highly dependent on the person who examines the stone and often varies by a substantial margin when valuations are made by different people. This has affected the gemstone value chain, and the country has not been able to achieve the expected export income through this industry. Therefore, an attempt is made here to address this issue by introducing an effective computer-aided system that utilises machine learning techniques for the valuation of gemstones. The overall methodology can be framed in five steps: development of criteria; modeling of a gemstone valuation baseline; system development; and accuracy assessment. After reviewing a large number of literature, fourteen criteria, namely colour,tone,saturation,hue,uniformity of coulour,clarity,cut,polish,shape,weight, treatment,general supply, provenance, and demand, were selected for gemstone valuation modeling. Then, scores were assigned to these factors based on their contributions and were evaluated using weighted overlay analysis. The evaluated scores were combined by the index overlay method to obtain an average score. A computer-aided system (ValGem) was developed to process and estimate the minimum value of a particular coloured gemstone based on the choice of the user, the calculated average score, and a pre-determined minimum reference value. This is a remote access system that allows gemstone data to be entered from an input device and the estimated minimum value to be received remotely. The modeled system showed above-90% accuracy with the existing market values. Thus, it is possible to conclude that the criterion used for this gemstone valuation modeling is well matched with the existing ground reality, and the developed system will benefit not only the gemstone traders but also the country's economy.

Key Words: *Gemstone, Valuation Modeling, WOA, Index Overlay Method*

GJRTI-2023-04

GIS-Based Approach for Mapping Potential Sites for Gem Mining and Identifying High-Risk Areas for Construction in Palmadulla DS Division

P.G.R.N.I. Pussella[1*], K.A.L.P. Rupasingha[1]

[1]*Faculty of Geomatics, Sabaragamuwa University, Belihuloya, Sri Lanka*
[*]*Corresponding Author:* pgrnip@geo.sab.ac.lk

This research focuses on mapping potential gem mining sites in Pelmadulla Divisional Secretariat using GIS-based approach. The study uses six factors to identify areas with a high likelihood of containing gem deposits. Factors such as distance from water features, land use, slope, elevation, flood areas, and proximity to existing gem-bearing locations are weighted using the Analytic Hierarchy Process (AHP) method to prioritize their influence on gem potential. The Weighted Overlay Analysis tool in ArcGIS was used to generate a comprehensive map indicating the locations of potential gem mining sites. Furthermore, the study investigated the effectiveness of three interpolation methods: Inverse Distance Weighting (IDW), Kriging, and Spline, in creating an underground surface for a gem-bearing layers. Different interpolation methods based on error metrics such as minimum error, maximum error, root mean square error (RMSE), correlation, and R^2 were used in order to reveal the most accurate method for estimating the gem bearing layer. The results suggest that IDW method exhibits the highest accuracy, while Kriging demonstrates lower RMSE values and a strong correlation with IDW. Additionally, the research addresses to identify high-risk areas for future constructions in the mining region by establishing a buffer zone around existing mining sites and using that digitizing a high-risk area map. Using this high-risk area map, developers and stakeholders can better assess the safety and feasibility of construction projects while avoiding potential hazards associated with underground tunnels. The study recommends to conduct further researches in the Rathnapura district to uncover undiscovered gem deposits. The collaboration with the relevant authorities to obtain data on previous mining sites enhances the accuracy of the risk zone map for the Pelmadulla area.

Key Words: *Gem Mine Mapping, AHP, IDW*

GJRTI-2023-05

Fluvial Dynamics of Wey River at Dela Based on Gem Pit Sediments

M.D.O.R. Jayalal[1*], P.R.U.S. Jayarathna[1], Pathmakumara Jayasingha[1]

[1]*Department of Geography,University of Colombo*
**Corresponding Author:* oshineeraveesha3@gmail.com

Gem pit sediments are an excellent piece of evidence for interpreting fluvial dynamics caused by paleoclimate. The study aims to interpret the fluvial dynamics of the Wey River in the Dela area based on Gem pit sediments. The studied three gem pits are in the Dela village area of Noragalla Grama Niladhari Division of Dela, Ratnapura District, distancing 42 m (pit A), 55 m (pit B) and 60 m (pit C) from the river. The sediment profiles of gem pits were meticulously sampled and the changes in sediment types were mapped. As per the feel analysis of the sediments (Thein, 1979), the sediment type was interpreted. In addition, observations on the physical environment (distance from gem pits to the river, fluvial morphology, landscape) in and around the gem pits were also used to interpret the dynamicity of the river. The studied gem pits were dug to a depth of 32 m (B) and 28 m (C) where the bedrock was found. The other pit (A) is still mining at the time of observation. The sediment layers of each profile were characterized by clay, sand, gravel, and pebbles, showing the changes in depositional patterns due to the different paleo-hydrological conditions of the river. The sand layers with a thickness of 1.5. m was recorded at 15.2 m (B) and 13.7 m (C) depths. Two sand layers were found at A with thicknesses of 2.3 m and 1.5 m at depths of 13 m and 20 m, respectively. The top gem gravel layer out of two beds was recorded at depths of 17.5 m (A), 11.4 m (B) and 10.4m (C). The lower layer was recorded at a depth of 22.8 m (A), 19 m (B) and 18 m (C), respectively. The textural characteristics of each sediment layer show the changes in depositional conditions governed by the amount of water in the river, hence the changes in climatic conditions. The gravel beds found there at the bottom of the gem pits indicate the bed load of the river and provide useful information on changes in the river course evidencing the fluvial dynamics of the Wey River. The thicknesses of the lower gravel beds at pit B and pit C, which are the thickest, were recorded as 13 m (B) and 10 m (C) indicating the shifting of the river path from the south to the present position or vice versa. It is well noted that the sand and gravel layers at different depths in each pit further confirm it and hence it can be concluded that the course of the Wey River has been shifted due to paleo climatic conditions with the due course of time. It is needed to do a geochronological and detailed sedimentological analysis to confirm the above idea of fluvial dynamics of the Wey River.

Key Words: *Fluvial dynamics, Gem pits sediments, paleo climates, gem gravel layer*

GJRTI-2023-06

Impact of Gem Mining for Rubber smallholdings: Case Study in Ratnapura District

P.K.K.S. Gunarathne[1*]

[1]*Rubber Research Institute of Sri Lanka, Ratmalana, Sri Lanka.*
[*]*Corresponding Author:* kapila.s.gunarathne@gmail.com

Both industries of gem mining and rubber farming are one of the Sri Lanka's major sources of income and employment generation. This paper examines the impact of gem mining for rubber smallholdings in Ratnapura District. Rubber smallholdings (n=113) who were doing gem mining in Ratnapura District was selected as study sample based on purposive sampling method in 2022. The data was collected by questionnaire survey and field observation. The majority of smallholdings' owners was in the age category of 46-55 years. Although legal gem mines were prominent (96%), few illegal gem mines (4%) were reported. The average land extent of rubber smallholdings for gem mining was 2.1 ha. while, the average damaged area of rubber trees was 1.4 ha (≈1210 tappable trees). The smallholdings which had unclosed abandoned gem pits were 5% of the study sample. In addition, reserved smallholdings were used only for gem mining and not used for rubber tapping. The average reserved land area for mining in the rubber smallholdings was 0.2 ha. Unclosed abandon gem pits and-a large amount of pile of clay, sand and stones of abandoned gem mines along with soil erosion in rubber smallholdings were reason for the decline fertility of the soil in rubber smallholdings. This reason is also caused adversely for the decline of rubber production. Estate officers mentioned that the illegal gem miners have destroyed many a rubber trees, consequently 150 to 200 of tappable rubber trees have been destroyed annually. The study provides valuable insights into the impact of gem mining in rubber smallholdings in Ratnapura and highlights the need for sustainable practices in the gem industry.

Key Words: *Abandoned rubber lands, Un-tapping*

GJRTI-2023-07

Variation in Garnet Composition as an Indicator for Gem Exploration: Evidence from Elahera Gem Field, Sri Lanka

R.M.N.P. K. Jayasinghe[1*], Chinthaka Gomes[1], S. Wijewardane[1], M.K.C. Jayamali[1], W.R. Lakshanthi[1], P.L.P.M. Liyanage[1] , P.G.S.M. Wijesooriya[2], T.H.P. De Silva[2], M.B.M. Gunasekara[2]

[1.] *Gem and Jewellery Research and Training Institute, Welivita, Kaduwela, Sri Lanka,*
[2] *Department of Geology, Faculty of Science, University of Peradeniya, Sri Lanka*
**Corresponding Author:* naleenlk@hotmail.com

Garnet is one of the most common minerals in skarn deposits and also has a solid solution series. The compositional variations of garnet can reflect its specific mineralization environment and can be an indication of its original hydrothermal fluids. The corundum-bearing skarn deposits in Elahera, Sri Lanka, are formed through the reaction of pegmatitic fluids with the marble, which proceeds in stages. Scapolite and corundum were produced in the initial reaction. As the Mg activity in the fluids increased, they became unstable and formed spinel and phlogopite. In this study, the abundance of different varieties of garnet was evaluated to assess the provenance of economic corundum occurrences in Elahera gem field. In order to analyse the garnets, samples were collected from the gem-bearing layers of seven existing gem mines, which are known to have varying potentials for corundum occurrences. Samples were subjected to sedimentological analyses, namely the granulometry and the morphometry of grains. The <250 µm sediment size fractions of each sample were selected and subjected to magnetic separation in stages using an isodynamic magnetic separator. Garnets have been separated at 0.40 Amp, 15°, 23°1.5 feed. Garnet verities in the samples are commonly grossular, almandine, pyrope, and rhodolite. The abundance of garnet varieties was estimated by visual comparison using a trinocular stereo zoom microscope. From the calculated ratios, it was observed that higher Pyrope Garnet/Almandine Garnet ratios correspond to high corundum potential. This indicates the formation of more pyrope garnet may have migrated Mg from the system and disturbed the transformation of corundum to spinel and/or events subsequent to their emplacement.

Key Words: *Corundum, Garnet, Skarn, Elahera*

GJRTI-2023-08

Analyzing Appropriate Cutting Angles for a Standard Cut of Various Gemstones Using Computer Software

K.G.S.S.W. Bandara[1], U.K.I. Dayarathne[1*], K.M.R.S. Konara[1], U. Rawsan[1]

[1]*Gem and Jewelry Research and Training Institute, Weliwita, Kaduwela*
[*]*Corresponding Author:* isuranga.dayarathne@gmail.com

Gem cutting and polishing is the major value-addition process of improving the beauty of rough gemstones. The beauty of the gemstones mostly depends on the quality of the cut and style. Cutting quality is the major factor affecting the gem stone. The brilliance of the cut depends on the selection of proper cutting angles according to the critical angle of the gemstone by saving total internal refraction. In the past, they used manual diagram techniques when designing standard cuts, which were often, considered weight saving factors rather than beauty because they had to no way observe beauty factors. The critical angle to ensure the brilliance of the gemstone was not considered there. Now, countries like China, Japan, Dubai, Bangkok, and Europe mostly consider beauty than weight factors. Therefore the standard gem-cutting designs are not suitable for the current situation. Therefore, this research aims to use gem CAD computer software to design proper angles for past standard gem cuts and qualitatively compare the beauty of past cuttings and newly designed cuts. Selected four gem varieties were Zircon, Sapphire, Topaz, and Quarts, which were laid in high, middle, and low RI range with three standard cuts; round brilliant, flower, and mixed cuts of brilliant crown with step pavilion. It has graphically compared past and newly designed cuts using proper critical angles and compared weight loss percentages. In addition, the coverage pavilion angle 45^0 - 60^0 of the existing cut has been reduced to 37^0 – 55^0 in the new cutting angle and the average weight loss percentage of the cut was 17.41% with the improvement of beauty. Therefore these newly designed cutting angles could be suggested for the lapidaries which consider the beauty rather than weight saving.

Key Words: *Brilliance, Critical angle, Gem CAD software, Standard gem cut*

GJRTI-2023-09

Introducing Silica Nanoparticles as a Gem Polishing Substance

M.A.N.C. Manthrirathna[1*], M.H.M. Shamri[2], B. Kowarthanan[2]

[1]*Gem and Jewelry Research and Training Institute, Walivita, Kaduwela, Sri Lanka*
[2] *Department of Applied Earth Sciences, Faculty of Applied Sciences,*
Uva Wellassa University, Sri Lanka
[*]*Corresponding Author:* nadeekamn@gmail.com

Although rice husk ash has been used for semi-precious gem stone polishing in the traditional gem industry in Sri Lanka, polishing with nanosized silica particles has not been reported yet. Here, we hypothesise that such polishing may protect gem surfaces against unwonted abrasion and give them a smooth surface. This study aimed to produce silica nanoparticles using rice husk and investigate their suitability for gem polishing. According to that rice husk samples were washed with distilled water to remove adhering soil and dust. Then acid-leaching step using a hot hydrochloric acid (HCl) solution removed metallic impurities prior to extracting silica from the rice husk. Samples were burned inside a programmable furnace. 1100 °C at a rate of 10 °C/min and soaked in a programmable furnace for 2 hours showed the maximum reactivity. Sodium hydroxide (NaOH) purification method was used to produce high-purity nanosilica powder. The 2.5 N NaOH treatment produced silica with a high purity. According to the XRF data, the percentage of pure silica in the extracted powder is 96.56%. Additionally, extracted nanosilica samples were analyzed using SEM (Scanning Electron Microscope), and nanosilica particles were used to polish semi-precious gem verities. The roughness of the polished surfaces was observed with microscope. The results obtained that, in comparison to traditional polishing pastes, nanosilica particles produce extremely smooth surfaces on gemstones when used to polish them.

Key Words: *Silica nanoparticles, Abrasion, Gem polishing*

GJRTI-2023-10

Enhancing the Blue Hue of Young Geuda Sapphires: Unraveling the Nitrogen Influence through Heat Treatment

Maheswaran Nirushan[1], Sandun Illangasinghe[2*], Chamal Jaliya[1]

[1]*Department of Applied Earth Sciences, Faculty of Applied Sciences, Uva Wellassa University, Passara Road, Badulla.*
[2]*Gem and Jewellery Research and Training Institute, Regional Center, Hidellana, Ratnapura.*
[*]*Corresponding Author:* sillangasinghe@gmail.com

Geuda, a corundum mineral found in Sri Lanka, and the heat treatment has been traditionally employed to enhance its allure. However, achieving precise conditions within traditional gas furnaces has presented significant challenges. Some methods have explored the introduction of additional gases, apart from Oxygen and Liquid Petroleum Gas (LPG), to further enhance the color of Geuda. However, the impact of Nitrogen gas as an additional gas on the blue hue of geuda sapphires remains largely unexplored. In this study, we examined three young geuda and one milky geuda (as a control) samples obtained from the Ratnapura gem market in Sri Lanka. One sample underwent slicing and polishing into four parts before undergoing heat treatment at 1700 °C for 12 hours under four distinct conditions: normal atmospheric, oxygen-enriched, nitrogen-enriched, and continuous nitrogen flow using a tube furnace. To assess changes in the samples before and after treatment, we employed visual color assessment through microscopy and the Gemological Institute of America (GIA) color grading scale. The observed color change in the young geuda samples after heat treatment highlights the blue hue, especially pronounced when subjected to a nitrogen-rich environment with a continuous nitrogen flow. Microscopic examination and GIA color grading confirmed that the intensity of the blue coloration is notably higher under conditions involving the constant flow of nitrogen. Under high-temperature conditions, nitrogen gas undergoes a transformation into nitrogen atoms, further accentuated when pressure is applied within the tube. This environment facilitates the Ti^{4+}/Fe^{2+} intervalence charge transfer process, potentially contributing to the enhanced blue coloration observed in the presence of flowing nitrogen. Thus, the findings suggest that the blue coloration in geuda sapphires under high-pressure conditions is enriched with nitrogen atoms, making it an ideal setting for the development of a striking blue hue.

Key Words: *Geuda Heat Treatment; Young Geuda; Geuda Treatment; Nitrogen*

GJRTI-2023-11

Quality Enhancement of Thick Silky Geuda by Thermal Treatment with Lakmini Gas Furnace

W.G.C.N. Wewegedara[1*], R. S. Diyabalanage[2], S.W. Nawaratne[3]

[1]Gem and Jewellery Research and Training Institute, Kaduwela, Sri Lanka
[2]Faculty of Applied Science, University of Sri Jayewardenepura, Sri Lanka
[3]Postgraduate Institute of Science, University of Peradeniya, Sri Lanka
[*]Corresponding Author: chandimawgcn@gmail.com

Low gem quality corundum that could be converted to high quality sapphire by means of heat treatment, referred to as “geuda” are commonly found in Sri Lankan gem gravels and represents nearly 70-80% of the unearthed gem varieties in most of the gem mines. Among the geuda varieties, thick silky geuda contain a significant number of bands of whitish rutile mineral impurities in one or more directions related to the crystal structure which leads to silky appearance and clarity depreciation. These geuda could be converted to gem quality blue sapphire by heat treatment, however low clarity enhancement and colour zoning have limited its applicability. Thus, the application of thermal treatments under different atmospheric conditions was experimented with in the present study to enhance the quality of thick silky geuda. Eighteen thick silky geuda samples were collected from Ratnapura, Sri Lanka and were divided into three groups. Heat treatment experiments were conducted using “Lakmini” gas furnace at reducing, oxidizing and mild oxidizing atmospheric conditions. Each firing was conducted up to 1850 ^{o}C with one-and-a-half-hour soaking period. Colour change was interpreted based on GIA colour grading standards while pre and post treatment chemical characterization was performed by using Energy Dispersive X-Ray Fluorescence (ED-XRF), Fourier Transform Infrared, Raman and UV-Visible spectroscopic techniques. Optimum results for thick silky geuda were obtained by treating under mild oxidative chamber atmospheric conditions where colour was improved to a blue hue, strongly saturated medium tone. Spectroscopic analysis revealed that the treated silky geuda can be distinguished by the introduction of OH peak at 3308.2 cm^{-1}, cause for the blue colour was charge transfer in $[Fe,Ti]^{6+}$ ion and no structural changes have occurred during the heat treatment determined by FTIR, UV-Visible and Raman analyses. No significant chemical changes were observed in ED-XRF analysi s following heat treatment. Colour zoning effect could not be eliminated and further studies are recommended.

Key Words: *Clarity depreciation, Colour zoning, Heat treatment, Charge transfer*

GJRTI-2023-12

A Raman Spectroscopic Investigation on the Effect of Heat Treatment on Geuda Stones

Limini M.D.Fonseka[1], Isiwara W. Y. Boteju[1], Ashan S. Gunarathna[1], Yasiru N. Jayathilaka[1], Siyath Gunewardene[1], Sasani Jayawardhana[2], Chamal Jaliya[3], Darshana L. Weerawarne[1], Hiran H.E. Jayaweera[1*]

[1]*Center for Instrument Development, Department of Physics, Faculty of Science, University of Colombo.*
[2]*Department of Materials Science & Engineering, National University of Singapore.*
[3] *Faculty of Applied Sciences, Uva Wellassa University.*
[*]*Corresponding Author:* hiran@phys.cmb.ac.lk

Sri Lanka is renowned for its natural Blue Sapphires. Low-cost precious stones can be converted to Blue Sapphires through heat treatment making it exceedingly difficult for the untrained eye to distinguish the difference. This study analyzes heat-treated Geuda stones (a member of the corundum family) via Raman spectroscopy to seek potential spectral features that can be used as a marker of differentiation. Two varieties, namely Young Geuda (YG) and Milky Geuda (MG), with a sample size of 10 each, were heat-treated up to 1650 °C under reducing conditions to enhance the blue color in the crystal. The heat treatment procedure was carried out using Sri Lanka's most abundantly used Lakmini furnace. Raman spectroscopy was used to study the color center modifications in the crystal structure. Raman peak narrowing was observed in more than 80% of Geuda at the peak 422 cm^{-1} for both YG and MG. Furthermore, the peak at 754 cm^{-1} was narrowed for YG. These peaks are characteristics of the lattice vibrations of the [AlO_6] group. Observed peak width variations can be attributed to the replacement of Al^{3+} ions by impurity ions Fe^{2+} and Ti^{4+} which distorts the crystal structure and is responsible for blue coloration. Supplementary analytical methods, FTIR (Fourier-transform infrared spectroscopy) and bulk transmission were used to confirm the conversion of Geuda to Blue Sapphire considering the peaks corresponding to the O-H functional group and to blue wavelengths respectively. Interestingly, more than 70% of the heat-treated Geuda showed a significant Raman peak broadening at 1125 cm^{-1} in the presence of this peak which is typically absent in natural Blue Sapphires. This broad peak corresponds to Al-O-Al bond vibrations. This Raman spectral feature in principle is a marker of differentiation, and can be utilized to develop cost-effective, rapid, in-situ Raman-based detection of heat-treated Geuda from natural Blue Sapphires.

Key Words: *Raman Spectroscopy, Geuda, Blue Sapphire, heat treatment*

GJRTI-2023-13

Harnessing cutting-edge technology to produce crackle quartz in Sri Lanka

U.K.I. Dayarathne[1*], B.G.R.W. Gamlath[1], H.W.M.M. Chandrasena[1], T.D. Anton[1]

[1]*Gem and Jewelry Research and Training Institute, Weliwita, Kaduwela.*
[*]*Corresponding Author:* isuranga.dayarathne@gmail.com

Quartz is an abundant gemstone with an underrated value, which should be subjected to a value-addition process to increase the value. Hence, crackle quartz is a production that is used for crystalline quartz by heating and quick cooling at specific temperatures to create cracks intentionally and allow penetration of dye varieties into the cracks. Although the production is available in the market, it is still not available in Sri Lanka due to some technical barriers such as necessary temperatures for producing cracks, non-formation of evenly distributed cracks, less ability to absorb dye varieties, inability to use multicolour, and absence of colour for a long time. Therefore, this study aims to address those barriers and to find solutions. Furthermore, through this research, it is hoped to produce a multicoloured production. First, quartz samples were heated up to a temperature of 450 °C by direct flame for 10 seconds and instantly placed in a water-cooling bath to form cracks. Then, these were allowed to absorb dye in a pressure chamber for 8 hours for deep absorption of colour. To obtain multicoloured production, part of the sample was sealed, and the procedure was repeated with different colours of dyes. Batik dye, metallic colour pigments, and organic dye varieties were used here. When metallic colour pigments were used, the optimum colour of the product was obtained due to the absorption of colours into newly formed cracks. Finally, a thin epoxy coating was applied to improve its beauty and durability. Therefore, this research confirms that this procedure can produce long-lasting multicolour crackle quartz with standard colour dyes with low production costs.

Key Words: *Color pigments, Crackle quartz, Multi-colouration, Value addition of quartz*

GJRTI-2023-14

Investigating Color Formation in Sri Lankan Geuda through Elemental Analysis

Gamage Ramesh[1], Sandun Illangasinghe[2*], Chamal Jaliya[1], Yuyang Zhang[3], Saranga Diyabalanage[4,5]

[1]*Department of Applied Earth Sciences, Faculty of Applied Sciences, Uva Wellassa University, Passara Road, Badulla, Sri Lanka.*
[2]*Gem and Jewellery Research and Training Institute, Regional Center, Hidellana, Ratnapura, Sri Lanka.*
[3]*Gemmological Institute, China University of Geosciences, Lumo Road, Hongshan District, Wuhan City, Hubei Province, China.*
[4]*Instrument Centre, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.*
[5]*Ecosphere Resilience Research Centre, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda, Sri Lanka.*
[*]*Corresponding Author:* sillangasinghe@gmail.com

In the Geuda heat treatment process, blue coloration is primarily determined by the trace element compositions in the Geuda. The blue coloration of heated sapphire is attributed to the Inter-Valance Charge Transfer (IVCT) process involving Ti^{4+} and Fe^{2+}. However, certain other trace elements (Mg^{2+} and Si^{4+}) have a negative impact on the IVCT process in sapphire. Therefore, a detailed investigation of the trace element composition and their correlation with blue color saturation after heat treatment is crucial to address color formation issues in the industry. Consequently, this research project examines the effect of Ti and Fe compositions on blue coloration in the Geuda heat-treatment process. Forty Geuda samples were collected from Bakamuna, Kathargama, Okkampitiya, Ratnapura, and Ridiyagama areas to encompass all potential gem-bearing regions in Sri Lanka. Samples were polished parallel to the c-axis and subjected to heat treatment at 1850 °C under reducing atmospheric conditions using Lakmini Gas Furnace. The major and trace elemental composition of the heated samples was analyzed using Energy Dispersive –Xray Fluorescence Spectroscopy (ED-XRF). The blue saturation index of the samples was determined using the Gemological Institute of America (GIA) color grading tool. Subsequently, the samples were categorized into three color groups: light, medium, and dark based on the blue saturation index. The relationship between Ti and Fe and the three color categories obtained was examined and the results clearly indicate a strong relationship between Ti and Fe and the color index categories, with R^2 values of 0.96 and 0.97, respectively. Therefore, these findings demonstrate that blue formation in Sri Lankan Geuda is primarily governed by the IVCT process involving Ti^{4+} and Fe^{2+}. Moreover, the results reveal that other trace elements interfering with the blue formation of Geuda are minimal. However, further trace element analysis using a highly accurate technique is recommended to confirm this conclusion.

Key Words: *Color pigments, Crackle quartz, Multi-colouration, Value addition of* quartz

GJRTI-2023-15

A Study on Country-Wise Exports of Gems and Jewellery from Sri Lanka

D.M.D. Ushana Senavirathne[1*], N.C. Wijesinghe[1]

[1]*Gem and Jewellery Research and Training Institute, Kaduwela, Sri Lanka.*
[*]*Corresponding Author: ushanasenevirathne@gmail.com*

The gem and jewellery industry in Sri Lanka has a rich history and plays a vital role in the country's economy. This research, conducted by the Gem and Jewellery Research and Training Institute, analyzes Sri Lanka's gem and jewellery exports from 2017 to 2021. The study's objectives were to understand export trends, the factors influencing them, and provide recommendations for industry growth. Data from various sources, including export statistics, was thoughtfully collected and analyzed to provide valuable insights. A comprehensive literature review provided context for industry dynamics. The research encompassed data collection, analysis, interpretation, and forward-looking speculation for a holistic view of the industry. Key findings emphasize the need to diversify export markets to ensure long-term growth, improve product quality, foster innovation, and collaborate with academia to develop a skilled workforce. Branding, ethical practices, and sustainability were highlighted as crucial for gaining a competitive edge. Government support through incentives and streamlined procedures was also discussed. The research identified diverse export patterns to different countries. The USA showed consistent growth, while Hong Kong experienced stability with occasional downturns. Thailand peaked in 2018 but declined afterward, and Switzerland had steady demand until 2019. Exports to China fluctuated, and Singapore saw both contraction and expansion. France and Germany reported comparatively lower export values. Additionally, the study examined the unexpected effects of the COVID-19 pandemic on the industry, such as increased transparency and regulatory scrutiny due to lockdowns and travel restrictions. Looking ahead to 2022-2026, the research anticipates continued recovery in 2022, followed by steady growth. Key focus areas include market diversification, quality enhancement, technological innovation, international collaboration, government support, and robust monitoring systems. Overall, this research offers a roadmap for Sri Lanka's gem and jewellery industry. By implementing the presented strategies and insights, Sri Lanka can solidify its position as a global hub for ethical and sustainable gem and jewellery products. The study invites all industry stakeholders to work together in shaping a brighter and more prosperous future for Sri Lanka's gem and jewellery exports.

Key Words: *Gems and Jewellery, Export, Marketing*

GJRTI-2023-16

Applications of Gravity Anomaly Data for Gem Potential Mapping: A Case Study from Kalthota, Sri Lanka

B.B.S.D Batugampala[1*], H.M.I. Prasanna[1], M.K.C. Jayamali[2] , R.M.N.P.K. Jayasinghe[2]

[1]*Department of Surveying & Geodesy, Faculty of Geomatics, Sabaragamuwa University of Sri Lanka.*
[2]*Gem and Jewellery Research and Training Institute, Kaduwela, Sri Lanka.*
[*]*Corresponding Author:* sdbsyr96@gmail.com

Sri Lanka has long been known for its encounters with precious, semi-precious, and rare gems. According to estimates, over 25% of Sri Lanka's entire land area has gemstone potential. It is essential to use natural resources in a sustainable manner in order to induce the least amount of disruption to nature. The usage of modern technological equipment is more popular in the world for this. Furthermore, GIS-based analysis has grown in popularity for identifying gem deposit locations. As a result, the use of GIS-based analysis to demarcate such resources is becoming more prevalent nowadays. The present case study has been carried out in order to precisely identify gem reserves in Sri Lanka using gravity anomaly data and GIS techniques. The research area, next to the Diyavinna Raja Maha Vihara, is distinguished by a paleo-landslide deposit with a secondary gem deposit ranging from 2.5 to 4.5 meters below the surface. The lithology, geological structures, and geomorphology in this location are beneficial to creating a gem gravel bed. Gravity readings derived from gravity surveys are intended to be employed as a significant factor in gem deposit surveys. As a consequence, the purpose of this study is to establish a relationship between the density and gravity values of gem-bearing sediments by collecting gravity data from various locations within the area that are correlated with known gem deposits. As a result, considerable gravity variations 94.096 mgal between the study location and the reference site were discovered. While isostasy predicts a mass deficit beneath the mountains, it cannot account for the strong gravity force seen in the research area. This kind of gravity difference shows the occurrence of high-density mass anomalies, which could suggest the presence of thick rock or mineral deposits. The gem potential model reveals that secondary gem resources, particularly corundum-type gems, have a significant potential for gem exploration in the research area. Finally, this study shows the feasibility of using gravity values as a valuable component in gem deposit mapping. These findings highlight the importance of collecting additional data in order to acquire more conclusive conclusions and to advocate expanding the study to new places with gem reserves. A deeper knowledge of gravity fluctuations with gem deposits can be acquired by expanding the study to additional places and examining the accompanying gravity values, which will contribute to a more precise mapping of gem deposits in Sri Lanka.

Key Words: *Isostasy, Anomalies, Gravity, GIS, Gem Potential*

GJRTI-2023-17

Detail Account of Gem Potentiality in Pelmadulla Area, Located in Upper Catchment of Kalu Ganga Basin

W.G.C.N. Wewegedara[1*], M.K.C. Jayamali[1], W.R. Lakshanthi[1], R.M.N.P.K. Jayasinghe[1]

Gem and Jewellery Research and Training Institute, Kaduwela, Sri Lanka
[*]*Corresponding Author:* chandimawgcn@gmail.com

Rathnapura gem field belongs to Kalu Ganga basin, and is the foremost gem field of Sri Lanka that has produced the finest gemstones in history, dating back over 2500 years. Denawak Oya and Wey Ganga are the major tributaries of Kalu Ganga which drain through the Pelmadulla source area carrying gems enriching the entire basin. Current work is mainly focused on detailed studying of the gem occurrences of Pelmadulla area compiling an account of deposits and preparation of a topographic map to trap the gem potentiality of the area more precisely that will be beneficial for the sustainable use of gem resources. Initial field investigations to obtain textural, structural, mineralogical and geological observations of the gem fields were conducted. ArcGIS 10.1 software was used to obtain the preliminary gem potential map by the weighted Overlay method. Distance to geological structures, elevation, slope, distance to drainage systems and flood areas, paddy areas, distance to geological structures and rock layers were the seven parameters considered. Data validation and finalizing of the resulting map was conducted based on field auger sampling and laboratory data obtained through grain counting of field samples. Two types of gem deposits were identified in the study area namely eluvial deposits in hill slopes and flat areas incised by valleys, and alluvial deposits along with the flood plains of the streams and palaeochannels. It could be named mainly as the Wey Ganga alluvial deposit, Nilagama eluvial deposit and Denawak Oya alluvial deposit. The depth of the deposits varies between 5 to 30 meters. Corundum (blue sapphire, yellow sapphire, star sapphire, geuda and rarely ruby), spinel, tourmaline, garnet, and zircon are the commonly foundgem varieties. The main source rocks could be Khondalite (garnet-sillimanite-biotite gneisses), impure marbles and Garnet Gneisses formed by silica under-saturate conditions during the Precambrian era. Based on the microscopic studies an average of, 0.2% of yellow sapphire, 0.1% of blue sapphire, 0.4% of geuda, 4% of spinel, 2% of garnet, 1% of zircon and tourmaline are the main gem minerals found in these gem fields. The produced Gem potential map could be used in spotting high-potential lands effectively.

Key Words: *Mineralogical, Eluvial, Alluvial, Weighted Overlay*

GJRTI-2023-18

Introducing a New Polishing Powder from Corundum (Kottara) to Replace Diamond Powder through a Scientific Studyon the Properties of Diamond Powder

U.K.I. Dayarathne[1*], M.A.N.C. Manthrirathna[1], M.H.M. Shamri[2], B. Kowarthanan[2], N.R. Rowthlies[1]

[1]*Gem and Jewellery Research and Training Institute, Waliwita, Kaduwela*
[2]*Department of Applied Earth Sciences, Faculty of Applied Sciences, Uva Wellassa University, Srilanka*
[*]*Corresponding Author:* isuranga.dayarathne@gmail.com

Gem polishing is the process of enhancing the appearance and value of valuable gems. Diamond powder is a polishing material for finer polishing in the gem industry and is a finely graded and exceptionally abrasive substance with a Mohs hardness of 10. The industrial diamond powder particle size is 20 µm to 500 µm. Even though diamond powder has good polishing properties and high hardness value it is expensive to produce because it is made from low-grade natural diamonds, so the cost can be impractical for some applications, especially when more affordable abrasives can achieve satisfactory results. Srilanken gem polishing industry is mainly based on semi-precious gemstones which mostly have a Mohs hardness below 9. So, this study is mainly focused on using corundum as a polishing material to reduce the particle size and to use instead of diamond powder because it has a Mohs scale of 9 and is abandoned in Sri Lanka. The development of a new corundum polishing compound can benefit the Sri Lankan gemstone polishing industry as well as reduce the polishing cost of gemstones. Firstly kottara (low-grade corundum) was collected from many areas in Sri Lanka and crushed into powder by using the ball mill for 4 hours at 50 rpm. Then the powdered sample was subjected to the suave machine and the tiniest powder material was obtained. Finally, to separate it the water suspension method was used and the filtrate was analysed with the LPSA. The analysed corundum powder was used to polish two identical gemstones to check the quality of the new corundum powder. The LPSA confirmed the material size of the sample was reduced up to 20-40 µm, the gem microscope images confirmed the polishing of the gemstones had successfully occurred and the polished gemstones confirmed the quality of the gemstones had been enhanced.

Key Words: *Corundum powder, diamond powder, kottara, LPSA*

GJRTI-2023-19

Introduce a Rechargeable Gem Testing Torch (3 in 1 type) with Low Cost and Advanced Technology

U.K.I. Dayarathne[1], A.S.N.K.M.C. Premakumar[1*], K.M.R.S. Konara[2], M.M.D. Sathsara[1]

[1]Gem and Jewellery Research and Training institute, Walivita, Kaduwela
[2]Gem and Jewellery Research and Training institute, Ratnapura
[*]Corresponding Author: malith@gemhill.lk

The gem testing torch (3 in 1 type) is a specialist instrument used in the examination of gems, provides distinct lighting sources, including white, yellow, and ultraviolet, for the examination and characterization of gemstones. A notable proportion of these torches is presently imported from other countries like China, Malaysia with some local brands manufacturing in Sri Lanka. However, it has been noted that due to the expensive price, technical flaws, and inefficiency of the torch now on the market, individuals in the industry are not satisfied. Aside from that, the majority of torches currently on the market only emit long-wave ultraviolet light (365 nm), but some gemstones need to be tested with short-wave ultraviolet light (254 nm), which is not currently available in most torches. Additionally, modern torches employ LED bulbs which are not suitable for gem testing, because they are appropriate for less voltage, yet a high-capacity tungsten lamp is necessary for an accurate gem testing. In order to overcome these limitations a highly efficient torch was created. The circuit of the torch, which was manufactured locally, was made by the acquisition of necessary tools and equipment. Focus lens was made by glass and tungsten bulbs sourced from China. Aluminum, brass, and rubber were used for development of the torch body, and the final result was created through assembling every component. The tungsten bulb and focus lens facilitate the detection of inclusions, cracks, and geuda within gemstones. LED yellow and white lights prove valuable for precise color identification, while high UV and low UV lights unveil the stone's fluorescence properties. The torch was successfully engineered, effectively addressing these challenges in a cost-efficient manner.

Key Words: *capacity, circuit, tungsten bulb, UV light, 3 in 1 type*

Author Index

2023

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(Ministry of industries)

ISSN 3021-6664

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