THE GEMMOLOGISTS ASSOCIATION OF SRI LANKA

in collaboration with the

NATIONAL GEM AND JEWELLERY AUTHORITY

Present

GEMMOLOGISTS ASSOCIATION RESEARCH SYMPOSIUM 2024

GARS 2024

PROCEEDINGS OF GEMMOLOGISTS ASSOCIATION RESEARCH SYMPOSIUM 2024

GARS 2024

"Gemmological Research and Development Towards Global Economic Development”

30th November 2024

Hector Kobbekaduwa Agrarian Research and Training Institute,
114, Wijerama Mawatha, Colombo 07

EXTENDED ABSTRACTS

Co-Editors

Mr. N.I. Balage
Mr. S.V.T.D. Raveendrasinghe
Mr. K.A.G. Sameera

Executive Committee
Gemmologists Association of Sri Lanka 2023/2024

President	- Mr. Nuwan Ishara Balage
Immediate Past president	- Mr. G.W. Udaya Kumara
General Secretary	- Mr. Shehan Daulagala
President-Elect	- Mr. Samitha Liyanage
Vice President (Education)	- Mr. K.A.G. Sameera
Vice President (Promotion)	- Mrs. C. Arthanayake
Asst. Secretary (Education)	- Mr. Sunil Premarathna
Asst. Secretary (Promotion)	- Mr. A.I.M. Zarookkhan
Treasurer	- Mr. Pushpa Perera
Asst. Treasurer	- Mr. R.L.D.S. Ranasinghe
Editor	- Mr. R.S. Gunasekara

Committee Members

Dr. Gamini Zoysa
Mr. U.K.A.S. Yapa
Mr. Rusiru Doraliyagoda
Mr. P.R.K.Fernando
Mr. L.M.C.S.A. Abeymanna
Dr. Ruvan Karunadasa
Mr. M.F.M. Asjed Faraj
Mrs. Shashee Malalasekara

Symposium Chair

Dr. Gamini Zoysa

Symposium Secretary

Mr. K.A.G. Sameera

Panel of Reviewers

Prof. S.W. Nawarathne
Prof. G.W.A. Rohan Fernando
Prof. P.G.R. Dharmarathna
Prof. Sanjeewa P.K. Malaviarachchi
Dr. Pathmakumara Jayasinghe
Dr. N.H. Koralegedara
Dr. P.L. Dharmapriya
Dr. Chanka Sandaruwan
Dr. M.N.P. Dushyantha
Mr. Samantha Gunasekara
Mr. Daya Ranasinghe
Mr. P.R.K. Fernando
Mr. S.V.T.D. Raveendrasinghe
Mr. R.G. Chamal Jaliya

Proceedings of Gemmologists Association Research Symposium 2024

GARS 2024

"Gemmological Research and Development Towards Global Economic Development”

ISSN 3021- 6982

Published by,

Gemmologists Association of Sri Lanka
275/75,
Stanley Wijesundara Mawatha,
Colombo - 07,
Sri Lanka.

Tel: +94 117 202 032
Website: www. gemmology.lk

Gemmologists Association Research Symposium 2024

GARS 2024

Gemmologists Association of Sri Lanka

Date : 30.11.2024

Venue : Hector Kobbekaduwa Agrarian Research and Training Institute, 114, Wijerama Mawatha, Colombo 07.

PROGRAMME

01.30 p.m. - 02.00 p.m.	Registration of Participants
02.00 p.m. - 02.05 p.m.	National Anthem
02.05 p.m. - 02.10 p.m.	Welcome address by Mr. N.I. Balage (President - GASL)
02.10 p.m. - 02.15 p.m.	Address by Dr. Gamini Zoysa (Chair - GARS 2024)
02.15 p.m. - 02.20 p.m.	Address by the Chief Guest, Mr. Naveen Sooriyarachchi, Chairman, National Gem & Jewellery Authority.
02.20 p.m. - 02.30 p.m.	Keynote address by Prof. Ranjith Premasiri, Director General, Geological Survey and Mines Bureau
02.30 p.m. - 03.45 p.m.	Technical Session I (Chairperson - Prof. P.G.R. Dharmarathne, Rapporteur - Mr. P.R.K. Fernando)
03.45 p.m. - 04.00 p.m.	Refreshments
04.00 p.m. - 05.15 p.m.	Technical Session II (Chairperson - Prof. Rohan Fernando, Rapporteur - Mr. P.R.K. Fernando)
05.15 p.m. - 05.25 p.m.	Recognitions of Reviewers/ Presenters and Certificate Awarding
05.25 p.m. - 05.30 p.m.	Vote of Thanks by Mr. K.A.G. Sameera (Secretary - GARS 2024)

Gemmologists Association Research Symposium 2024
GARS 2024

30th November 2024
Technical Session I

Chairperson : Prof. P.G.R. Dharmarathne

Rapporteur : Mr. P.R.K. Fernando

Panelist : Prof. Ranjith Premasiri, Mr. B.G.R.W. Gamlath

02.30 - 02.45	ORIGIN DETERMINATION OF NATURAL YELLOW SAPPHIRES USING IN SITU-TRACE ELEMENT ANALYSIS M. Seneewong-Na-Ayutthaya, B. Wanthanachaisaeng, T. Leelawatanasuk W. Suwanmanee, T. Lhuaamporn, P. Kamkeaw, T. Sripoonjan
02.45 - 03.00	CHARACTERISATION OF A NEW TYPE OF SINHALITE FROM SRI LANKA: MICROSCOPIC INCLUSIONS, 3D FLUORESCENCE IMAGING, AND TRACE ELEMENT ANALYSIS S. Illangasinghe, H. M. M. Kulasooriya, Y. Zhang, M. Chen, L. V. Ranaweera, N. Jayasinghe
03.00 - 03.15	IDENTIFICATION OF POTENTIAL TO DEVELOP GEM TOURISM IN RATHNAPURA DISTRICT, SRI LANKA K. U. K. Kodikara, U. L. T. S. Randeepa, V. Wickramarathna, S. llangasinghe, C. Wawegedara, N. Jayasinghe
03.15 – 03.30	RAMAN SPECTROSCOPIC INVESTIGATION OF FLUORESCENT AND NON-FLUORESCENT SRI LANKAN CORUNDUM A.H.P.K. Seenigama, P.G.B.R.L. Bandaraa, R.G.C. Jaliya, S. Illangasinghe
03.30 – 03.45	COLOUR ZONING IN HEAT-TREATED GEUDA SAPPHIRE DUE TO TRACE ELEMENT COMPOSITION S. Illangasinghe, Y. Zhang, M. Chen, N. Jayasinghe

Gemmologists Association Research Symposium 2024
GARS 2024

Technical Session II

Chairperson : Prof. G.W.A. Rohan Fernando
Rapporteur : Mr. P.R.K. Fernando
Panelist : Mr. Samantha Gunasekara, Mr. R.L.D.S. Ranasinghe

04.00 – 04.15 ENHANCEMENT OF COLOR IN NIGERIAN PINK TOURMALINE THROUGH HIGH-ENERGY ELECTRON IRRADIATION

B. Wanthanachaisaeng, W. Suwanmanee, M. Seneewong-Na-Ayutthaya, W. Chongraktrakul, P. Kamkeaw, S. Saengdech, <u>G. Zoysa</u>

04.15 – 04.30 INVESTIGATING HEAT TREATMENT EFFECTS ON SRI LANKAN BLACK/BROWN (MAANGU) TOURMALINE: A STUDY OF COLOR TRANSFORMATION AND CLARITY ENHANCEMENT

<u>V. Wickramarathna</u>, S. Illangasinghe, C. Jaliya, C. Arthanayaka

04.30 – 04.45 SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT OF THE GEM INDUSTRY IN RATHNAPURA AND MONARAGALA DISTRICTS

<u>D. L. Dasanayaka</u>, S.W. Nawarathna, H.H.D.A.L. Siriwardhana

04.45 – 05.00 DIFFERENTIATING MADAGASCAR AND SRI LANKAN LOW-GRADE SAPPHIRE USING UV-VISIBLE SPECTROSCOPY

<u>P.G.B.R.L. Bandara</u>, A.H.P.K. Seenigama, R.G.C. Jaliya, S. Illangasinghe

05.00 – 05.15 APPLICABILITY OF GEOCHEMICAL SIGNATURE OF SEDIMENTS TO DELINEATE GEM POTENTIAL AREAS: PRELIMINARY INVESTIGATION IN NEELAGAMA, RATHNAPURA, SRI LANKA

S. Diyabalanage, <u>S. Illangasinghe</u>, N. Jayasinge

ORIGIN DETERMINATION OF NATURAL YELLOW SAPPHIRES USING IN SITU-TRACE ELEMENT ANALYSIS

M. Seneewong-Na-Ayutthaya[a*], B. Wanthanachaisaeng[a], T. Leelawatanasuk[a] , W. Suwanmanee[a], T. Lhuaamporn[a], P. Kamkeaw[a], T. Sripoonjan[b]

[a]*The Gem and Jewelry Institute of Thailand (Public Organization), ITF-Tower Building, Silom Road, Suriyawong, Bangrak, Bangkok, 10500 Thailand.*
[b]*G-ID Laboratories in Yannawa, Bangkok, 10120 Thailand.*

**Corresponding author: smontira@git.or.th*

Yellow sapphires, a gemological variety of corundum (Al_2O_3), are found in specific regions worldwide and typically crystallise in metamorphic and basaltic rocks. Variations in physical parameters and geochemical factors such as internal features and trace element compositions, respectively, prevailing in geological formations, result in differing gemological properties of these minerals. This study investigates an origin determination scheme for yellow sapphires through chemical analyses employing EDXRF and LA-ICP-MS. A comparative analysis was conducted on 153 samples from significant geographical sources-including Sri Lanka (Ratanapura), Madagascar (Ilakaka), Tanzania (Tanga), and Thailand (Bangkaja)-to emphasise the unique phyisico-chemical signatures associated with respective regions that play critical roles in origin determination. The results indicate that trace element concentrations exhibit relatively well-defined distribution patterns, with each source forming distinct clusters. This clustering facilitates the classification of sapphire samples based on their trace element compositions. Iron (Fe) emerges as an essential trace element in determining the geographic origin of sapphires, along with other elements such as titanium (Ti), vanadium (V), chromium (Cr), gallium (Ga), and magnesium (Mg). The chemical results showed that the LA-ICP-MS revealed a clearer trend in origin determination compared to the EDXRF. For example, scatter plots of element combinations such as Fe-Cr, Fe-Ga, Fe-Cr-Ga, and Fe-Mg-Cr effectively distinguished sapphire samples from different sources. However, some overlapping distributions of trace elements were still observed

between the Tanzanian and Thai samples. Sri Lanka and Madagascar samples exhibit lower iron content, attributed to their geological origins as metamorphic rocks from gem-bearing gravels. Similarly, yellow sapphires from Tanga, Tanzania, originating from metamorphic deposits, show medium iron content compared to all samples. The Bangkaja area in Thailand is a basalt-related deposit, and the yellow sapphires from this region show the highest iron content. The study focuses on the potential of using trace elemental analysis as a robust method for provenance assignment, thereby enhancing our understanding of the effect of geological processes on the gemological characteristics of yellow sapphires.

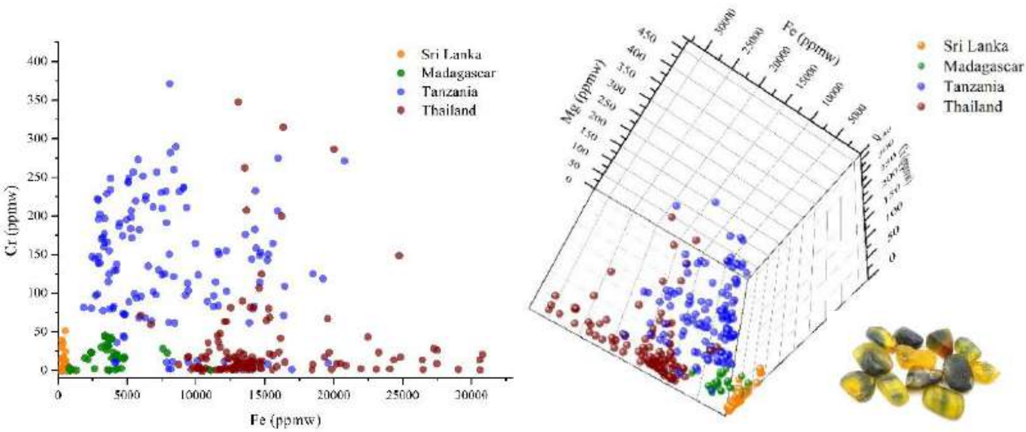

Fig. 1. Chemical scatter plots of trace element contents by LA-ICP-MS for yellow sapphires from Sri Lanka, Madagascar, Tanzania, and Thailand.

Keywords: Yellow sapphire, Chemical fingerprinting, Origin determination, Trace element, LA-ICP-MS

CHARACTERISATION OF A NEW TYPE OF SINHALITE FROM SRI LANKA: MICROSCOPIC INCLUSIONS, 3D FLUORESCENCE IMAGING, AND TRACE ELEMENT ANALYSIS

S. Illangasinghe[a*], H. M. M. Kulasooriya[b], Y. Zhang[c], M. Chen[c], L. V. Ranaweera[d], N. Jayasinghe[a]

[a]*Gem and Jewellery Research and Training Institute, Hidellana, Ratnapura, Sri Lanka.*
[b]*National Gem and Jewellery Authority, Regional Office, Eheliyagoda, Sri Lanka.*
[c]*Gemmological Institute, China University of Geosciences, Wuhan, China.*
[d]*Department of Natural Resources, Sabaragmauwa University of Sri Lanka, Belihuloya, Sri Lanka.*

**Corresponding author: sillangasinghe@gmail.com*

A new type of sinhalite was recently discovered in the Kiriella area of Ratnapura, Sri Lanka. Until this discovery, sinhalite was classified as a non-silicate mineral with an olivine-like unit cell, and previous studies suggested that the substitution of Si^{4+} ions in its structure was impossible. However, this newly identified type of sinhalite provides the first evidence of Si^{4+} incorporation into the Sinhalite structure. The average chemical composition of this new sinhalite is $Mg_{1.04}Fe_{0.02}Al_{1.01}Si_{0.02}B_{0.94}O_4$. A detailed gemmological investigation into this new Sinhalite is of great interest. Notably, there are no published studies on 3D fluorescence or trace elemental analysis of Sinhalite of any kind. This study presents the inclusions, 3D fluorescence images, and trace elemental composition of this new Sinhalite.
Four samples, previously confirmed to contain Si^{4+} content, were selected for analysis. The inclusions within the samples were examined using a gemological microscope, 3D fluorescence images were captured using a fluorescence spectrophotometer, and trace element analysis was conducted using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS).
Microscopic imaging revealed that some samples contained acicular inclusions, as depicted in Figure 1. These inclusions are commonly found in Sinhalite and have been identified as sillimanite mineral inclusions, suggesting that the inclusions in these samples are most likely sillimanite. While Sinhalite typically exhibits very weak fluorescence when tested with classical gemmological instruments, the 3D fluorescence analysis showed two distinct emission areas.

Excitation energy in the 350-380 nm range stimulated emissions around ~425 nm and ~715 nm. The colour of Sinhalite is attributed to spin-allowed and spin-forbidden electron transitions of Fe^{2+}, and these Fe^{2+} spin-allowed transitions are likely responsible for the observed fluorescence emissions.

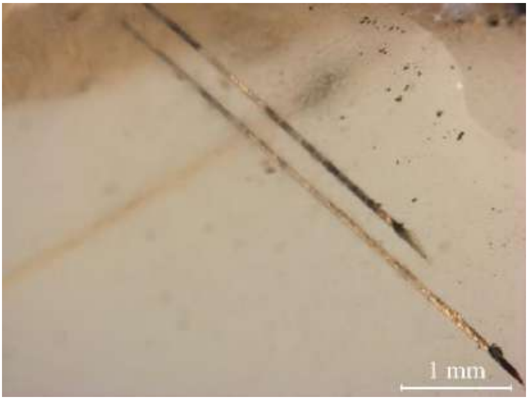

Fig. 1. Acicular sillimanite inclusions found within the sinhalite host mineral.

The trace element analysis revealed that most trace elements in Sinhalite are present at characteristically low levels, with many below the detection limit. However, Li and Zr consistently showed comparatively higher trace element abundances, implying their affinity for Sinhalite. Additionally, Cs, Rb, and Ba displayed occasional but relatively higher concentrations, though their presence was inconsistent across all samples.
The present study confirms that sillimanite mineral inclusions are characteristic of Sinhalite. The 3D fluorescence analysis showing two distinct emission regions, likely linked to Fe^{2+} spin-allowed transitions, provides new insights into the fluorescence behaviour of Sinhalite. Sinhalite is not a sink for trace elements, except for Li, Zr, Cs, Rb, and Ba.

Keywords: Sinhalite, Si^{4+} in Sinhalite, 3D Fluorescence Imaging, Trace elements

IDENTIFICATION OF POTENTIAL TO DEVELOP GEM TOURISM IN RATHNAPURA DISTRICT, SRI LANKA

K. U. K. Kodikara[a], U. L. T. S. Randeepa[b], V. Wickramarathna[c], S. Ilangasinghe[d*], C. Wawegedara[d], N. Jayasinghe[d]

[a]Department of Geography, University of Peradeniya, Peradeniya.
[b]Department of Archaeology and Heritage Management, Rajarata University of Sri Lanka, Mihinthale.
[c]Department of Applied Earth Science, Uva Wellassa University, Badulla, Sri Lanka.
[d]Gem and Jewellery Research and Training Institute, Regional Center, Hidellana, Rathnapura, Sri Lanka.

**Corresponding author: sillangasinghe@gmail.com*

Tourism, as defined by the United Nations World Tourism Organization (UNWTO), involves the movement of people outside their usual environment for personal or professional purposes. Gem tourism, a specialised sector, attracts visitors interested in gemstones and gem-related activities. Renowned for its prosperous gem industry, Sri Lanka holds significant potential for developing gem tourism, particularly in the Rathnapura region. According to the Sri Lanka Tourism Development Authority's 2020 statistics, ~87.3% of Sri Lank visitors sought relaxation and enjoyable experiences. The Rathnapura region, with its extensive gem mining and processing activities, offers unique opportunities for tourists to explore gem mining, processing, and trading. Open-air gem markets such as Demuwawatha, Abagahayata, Nivithigala, and Palmadulla further enhance its appeal, highlighting the region's potential for developing gem tourism by combining enjoyable experiences and business satisfaction. However, a lack of proper guidance and management hinders the industry's growth, limiting its progress. This study explores the perceptions of gem traders in Rathnapura to identify opportunities for advancing gem tourism, combining enjoyable experiences with business satisfaction to unlock the region's full potential.

A questionnaire assessed traders' perceptions of a gem tourism development program. Fifty gem traders, randomly selected from Nivithigala and Rathnapura open-air gem markets, were interviewed. Key areas examined included accommodation, infrastructure, hospitality, entertainment, IT, investment

potential, awareness of gem tourism, language skills, and relationships between local dealers and tourists. The data was analysed graphically.

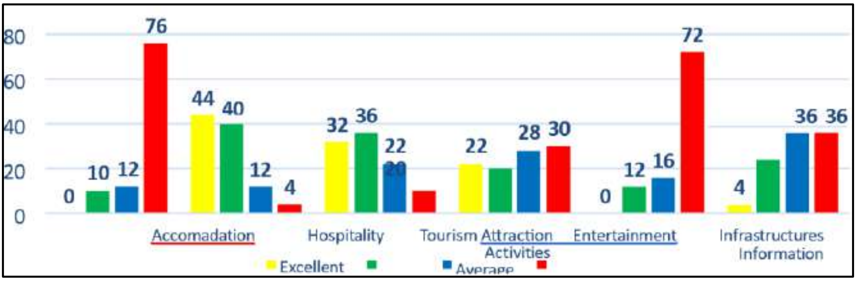

Fig. 1. Summary of survey data in Rathnapura Area.

According to graphical data plotted, 98 % of gem traders interviewed are willing to contribute by sharing knowledge, guiding on visiting fields and opening their industrial activities for tourists. Around 93 per cent of them have shown their willingness to invest. This shows a positive perception of gem traders in the developing gem tourism industry within the Rathnapura district. More than 70% of interviewees mentioned that hospitality in parallel to tourism attraction is high in the region. In addition, some constraints and challenges were recognised as well. Poor accommodation and infrastructure facilities (Ex, Luxury hotels, restaurants, adequate banking facilities, etc) were identified as significant constraints in developing gem tourism within this region. More than 70% of traders interviewed highlighted the need to build infrastructure and accommodation facilities within this region. This is proved by the annual statistical report 2023 published by the Sri Lanka Tourism Development Authority; the room distribution in Rathnapura district exhibits a notable low concentration of accommodations as a percentage of 1.3 compared with other districts in Sri Lanka. Furthermore, not developed communication setting between dealers and gem tourists was recognised as another major constraint. Only 16 % of traders can handle English fluently, whereas other language skills, such as Tamil, Chinese, French, and German, are significantly lower. Therefore, language skill development programs are needed to strengthen the bond between gem dealers and tourists. Only 50% of traders who have experience dealing with tourists commercially were reported. Thus, only a tiny portion of

those interviewed, like 15%, were recognised as having a good awareness of the gem tourism industry and abundant of them, around 50%, need more awareness. The information gathered shows the need to address these issues to develop gem tourism.
In conclusion, the data shows strong support from gem traders in Rathnapura for developing gem tourism, with 98% willing to share knowledge and 93% ready to invest in the gem tourism development program. However, challenges such as poor infrastructure, accommodation, language barriers, and limited awareness must be addressed. By improving these areas through infrastructure development, language training, and awareness programs, Rathnapura can unlock its potential for gem tourism, benefiting both the local economy and Sri Lanka's gem industry.

Keywords: Gem tourism, Ratnapura, Tourism potential

RAMAN SPECTROSCOPIC INVESTIGATION OF FLUORESCENT AND NON-FLUORESCENT SRI LANKAN CORUNDUM

A.H.P.K. Seenigama[a*], P.G.B.R.L. Bandara[a], R.G.C. Jaliya[a], S. Illangasinghe[b]

[a]*Department of Applied Earth Sciences, Faculty of Applied Sciences, Uva Wellassa University, Passara Road, Badulla, Sri Lanka.*
[b]*Gem and Jewellery Research and Training Institute, Welivita, Kaduwela, Sri Lanka.*

**Corresponding author: pasinduseenigama98@gmail.com*

Sri Lanka is famous for its gem industry, which has over 2000 years of historical evolution. Geological settings of the country have significantly contributed to this evolution of the industry. As a confirmation, researchers have discovered that 25% of the country's land area has the potential for gem-bearing deposits, and 75 gem verities have been found on the island. Sri Lanka is renowned for its diverse corundum gemstones. While some corundum varieties exhibit red fluorescence under ultraviolet (UV) light, the relationship between fluorescence and Raman spectroscopic characteristics remains unexplored. The fluorescence of gemstones under UV radiation is caused by the transition of an electron to the ground state from the exited state, which was excited by the incident UV radiation. The energy difference between absorbed and emitted photons is caused by the molecular vibration or heat, resulting in the fluorescence in the gemstone.

Fluorescence is a diagnostic characteristic of gemstones because fluorescence under UV radiation can distinguish natural and synthetic gemstones and occasionally heated corundum varieties. It is also used to identify elemental characteristics of gemstones, such as Cr^{3+} ions. Because chromic oxide is one of the significant fluorescence activators in corundum, this study aims to investigate the Raman spectroscopic differences between fluorescent and non-fluorescent Sri Lankan corundum. Ten fluorescent and ten non-fluorescent corundum samples were collected, faceted, purified using 1M HCl, and identified using a refractometer. Raman spectroscopy was employed to analyse the vibrational properties of these samples by using Gemmo Raman 532. The Raman spectra of both fluorescent corundum and non-fluorescent corundum exhibited characteristic peaks for corundum around 378 cm^{-1}, 418 cm^{-1}, 645 cm^{-1}, and 751 cm^{-1}. However, the Raman spectra of the fluorescent corundum consistently exhibited two prominent peaks in the 800-900 cm^{-1} region, centred around 835

cm^{-1} and 872 cm^{-1}. In contrast, these peaks were absent in the spectra of non-fluorescent samples. Fig. 1 shows the difference in Raman spectra of fluorescent and non-fluorescent Sri Lankan corundum.

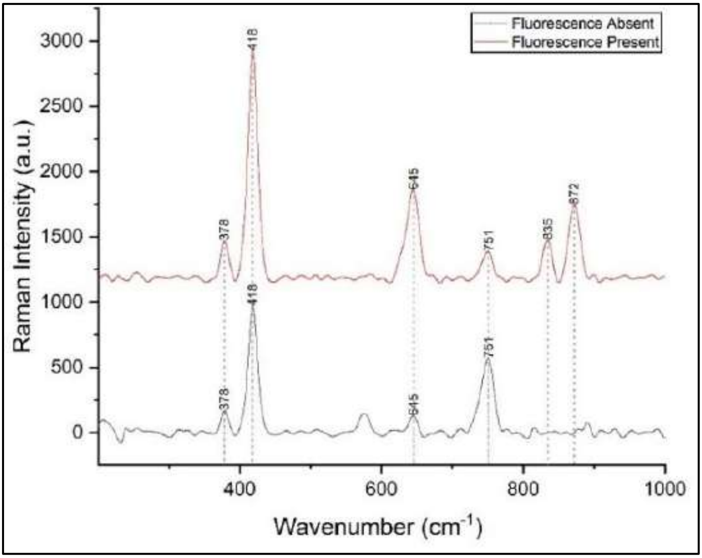

Fig. 1. Raman spectra of fluorescent and non-fluorescent Sri Lankan Corundum

This research suggests a correlation between specific Raman spectral features and the fluorescence behaviour of Sri Lankan corundum. Further investigation is wanted to elucidate the underlying mechanisms responsible for this phenomenon and explore its potential applications in gemological analysis and gemstone characterisation. Additional studies could also use Raman analysis to determine the presence of chromic oxide in corundum.

Keywords: Corundum, Fluorescence, Gemstone characterisation, Raman spectroscopy

Acknowledgement: The authors would like to thank Mr. G.A.K.S. Bandara (Gem cutting and polishing visiting instructor, GJRTI, Badulla) for providing service for preformed, faceted and polishing of the samples. The contribution by Mrs.

M.A.N.C. Manthrirathna (Research officer, GJRTI) and Mr R.M.N.P.K. Jayasinghe (Director - Research, GJRTI) from Gem and Jewellery Research and Training Institute (GJRTI) in the Raman analysis is gratefully acknowledged.

COLOUR ZONING IN HEAT-TREATED GEUDA SAPPHIRE DUE TO TRACE ELEMENT COMPOSITION

S. Illangasinghe[a*], Y. Zhang[b], M. Chen[b], N. Jayasinghe[a]

[a]*Gem and Jewellery Research and Training Institute, Hidellana, Ratnapura, Sri Lanka.*
[b]*Gemmological Institute, China University of Geosciences, Wuhan, China.*

**Corresponding author: sillangasinghe@gmail.com*

Fine blue sapphire is often produced by heat-treating geuda sapphire. However, in some cases, this heat treatment results in blue color zoning, which poses a significant challenge in the geuda heat treatment industry. The blue colour of sapphire is mainly due to an Inter-Valence Charge Transfer (IVCT) process between Ti^{4+} and Fe^{2+}. Previous research has suggested that other trace elements, such as Si^{4+} and Mg^{2+}, might also influence this colour formation. Therefore, Ti^{4+}, Fe^{2+}, Si^{4+}, and Mg^{2+} all may play a role in controlling the blue colour formation during the heat treatment of geuda.

This study investigates how these trace elements affect colour zoning. Four samples with colour zoning after heat treatment were selected from major gem-producing regions in Sri Lanka: BK-04 from Bakamuna, OP-07 from Okkampitiya, RG-10 from Ridiyagama, and RT-07 from Ratnapura. Fourier Transform Infrared (FTIR), UV-visible absorption spectroscopy, and microscopic images were obtained before and after heat treatment. Major and trace elements in the coloured and colourless zones were measured using the Laser Ablation Inductive Coupled Plasma Mass Spectrometry (LA-ICP-MS) method. Two spots in each zone were tested, and average values were taken.

The microscopic analysis supported the visual identification of the degree of colour enhancement before and after heat treatment. The UV-VIS spectra confirmed that the blue colour enhancement was caused by the Inter-Valence Charge Transfer (IVCT) mechanism between Fe^{2+} and Ti^{4+} ions. The FTIR analysis demonstrated its effectiveness in identifying heat-treated blue sapphires, with the characteristic peak at 3310 cm^{-1} appearing after heat treatment.

The results show that Ti, Fe, Si, and Mg concentrations in the colourless areas range from 191-379 ppm, 566-1326 ppm, 4060-6093 ppm, and 124-153 ppm, respectively. In the coloured areas, the concentrations range from 173-430 ppm

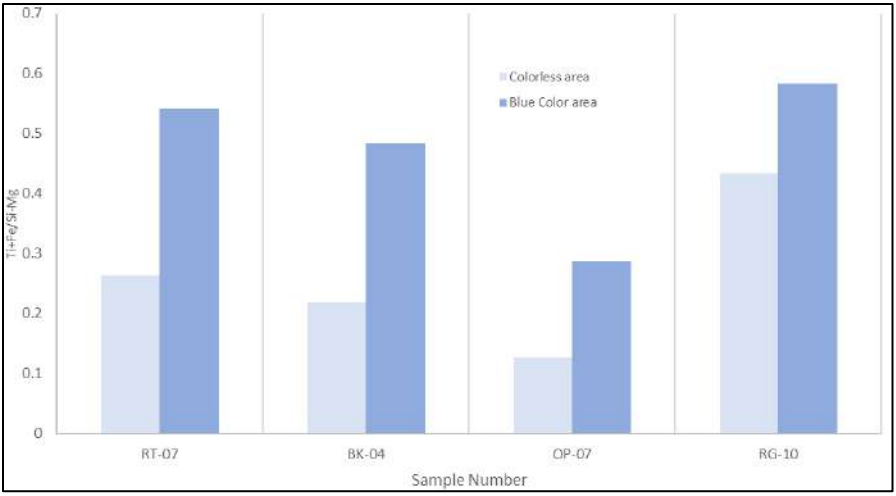

Fig. 1. The value of Ti+Fe/Si-Mg in all samples' colour and colourless zone.

635-1481 ppm, 2156-3585 ppm, and 62-198 ppm, respectively. Additionally, the Ti+Fe/Si-Mg ratio in the coloured zones is higher than in the colourless zones for all samples (see Figure 1). These findings suggest that the Ti+Fe/Si-Mg ratio likely plays a crucial role in controlling colour zoning in geuda heat treatment. Further analysis is recommended to confirm this conclusion.

Keywords: Color zoning of sapphire, Trace element in sapphire, Blue in sapphire

ENHANCEMENT OF COLOR IN NIGERIAN PINK TOURMALINE THROUGH HIGH-ENERGY ELECTRON IRRADIATION

B. Wanthanachaisaeng[a*], W. Suwanmanee[a], M. Seneewong-Na-Ayutthaya[a], W. Chongraktrakul[a], P. Kamkeaw[a], S. Saengdech[a], G. Zoysa[b]

[a]*The Gem and Jewelry Institute of Thailand (Public Organization), ITF-Tower Building, Silom Road, Suriyawong, Bangrak, Bangkok, 10500 Thailand.*
[b]*Consultant Gemmologist Ceylon Gemmological Services Colombo, Sri Lanka.*

**Corresponding author: wbhuwadol@git.or.th*

Irradiation has become an increasingly popular technique for enhancing the colour of gemstones, especially beryl tourmaline and topaz. Radiation can intensify the colour of gemstones, making them more visually appealing and, as a result, increasing their market price. Many gemstone dealers commonly enhance the pink colour of tourmaline to an intense red, comparable to that of rubellite, as vivid-coloured gems, exceptionally bright red ones, are valued higher than lighter-coloured gems due to their more significant demand in the gem market. In this study, pink tourmalines from Nigeria, acquired from a gem dealer in Thailand, were selected for colour enhancement using electron irradiation provided by a linear accelerator manufactured by Mevex Corporation Ltd., Model MB 20-16, Canada. The experimental parameters include a radiation dose of 6,000 kGy, energy of 20 MeV, and dose rate of 400 kGy/hour. All samples were first cut, polished, photographed, and documented for standard properties, together with hues, absorption spectrum, and chemical composition analysis by LA-ICP-MS. The samples were then annealed at 700°C in atmosphere conditions for 1 hour to reduce their colours, often turning them colourless. Following this, the samples were treated with high-energy electron radiation at a dose of 6,000 kGy for 15 hours. The samples were photographed before and after each experiment step, and their hues and spectra were recorded. The experimental results indicate that the trace elements manganese (Mn) and iron (Fe) can serve as a reference database for predicting the colour of pink tourmaline and enhancing its colour quality through irradiation techniques. After irradiation, samples with high Mn and Fe content developed red and dark pink hues. In contrast, those with low Mn and low Fe content and samples with low Mn but high Fe displayed intense yellow, orangey-brown, or

reddish-brown hues. Electron irradiation at doses of up to 6, 000kGy does not leave residual radiation in the samples. Therefore, it is considered a suitable method for enhancing the colour quality of pink tourmaline to increase its value, offering an alternative to gamma irradiation.

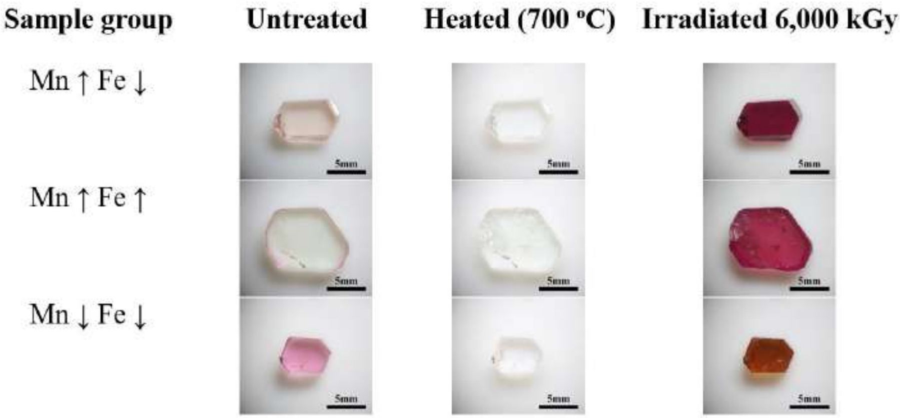

Fig. 1. Comparison of colour changes in Nigerian tourmaline before and after treatment with electron beam irradiation.

Keywords: Pink tourmaline, Color enhancement, Annealing treatment, Electron radiation, Trace elements

INVESTIGATING HEAT TREATMENT EFFECTS ON SRI LANKAN BLACK/BROWN (MAANGU) TOURMALINE: A STUDY OF COLOR TRANSFORMATION AND CLARITY ENHANCEMENT

V. Wickramarathna[a], S. Illangasinghe[b*], C. Jaliya[a], C. Arthanayaka[c]

[a]*Department of Applied Earth Science, Uva Wellassa University, Badulla, Sri Lanka.*
[b]*Gem and Jewellery Research and Training Institute, Regional Center, Hidellana, Rathnapura, Sri Lanka.*
[c]*Tokyo Gemological Centre, Colombo 04.*

**Corresponding author: sillangasinghe@gmail.com*

Tourmaline is a complex borosilicate mineral with a highly variable chemical composition, giving various colours and properties. This diversity in chemical structure is responsible for the numerous colour varieties of tourmaline. In Sri Lanka, the Precambrian basement rocks are known to produce several gem-quality tourmaline varieties, with yellow and brown hues being the most prominent. Among these, brown translucent tourmaline is commonly found and usually referred to as “maangu” by local gem traders. However, despite its prevalence, the commercial potential of this material remains untapped mainly due to its less desirable colour and clarity than other tourmaline varieties. Heat treatment is a well-established method in the gem industry used to enhance the colour and clarity of various gemstones. However, limited research has been conducted on the effects of heat treatment on brown tourmaline, particularly the dravite type. This research explores the feasibility of applying heat treatment techniques to improve the aesthetic qualities of Sri Lankan dravite tourmaline.
Six “Maangu” tourmaline samples were collected and polished on parallel faces. Before heat treatment, GIA colour grading, UV-visible, and Fourier Transform Infrared (FTIR) absorption spectroscopy analyses were conducted. The samples were then subjected to heat treatment at 550°C, 650°C, and 750°C under modified atmospheric (oxidising or reducing) conditions, with a soaking time of three hours using a “LAKMINI” gas furnace. After the treatment, GIA colour grading, UV-visible, and FTIR absorption spectroscopy analyses were repeated.
After heat treatment, the colour grading results show that the original brown colour shifted toward an orange hue. Additionally, the colour change was most optimised in samples heat-treated at 550°C. Heating at 550°C caused a slight

lightening of the darkness along the polarisation direction, giving a greenish appearance. In contrast, the colour shifted from brown to orangish hues with a slight increase of the darker appearance along other polarisation directions. Note that “Maangu” tourmaline usually contains the property of dichroism with yellowish brown and green colour. Figure 1 shows corresponding UV-visible and FTIR spectrum changes of a studied sample hated at 550°C, which caused such changes in optical properties.

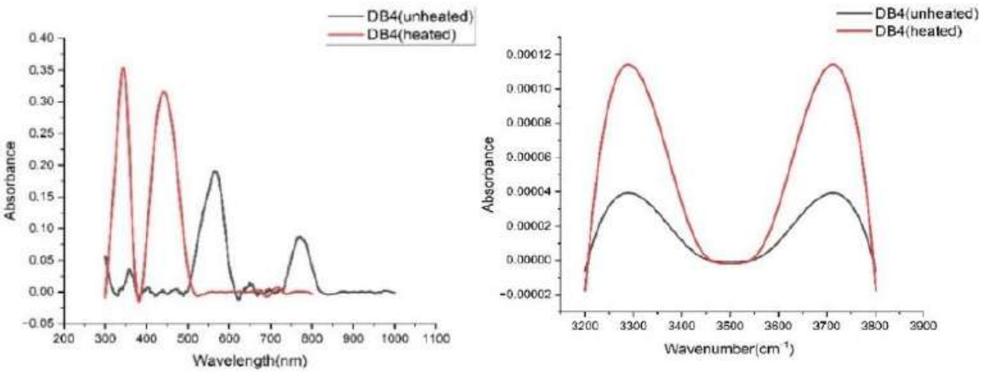

Fig. 1. Unheated and heated dravite samples' UV-visible (Right) and FTIR (Left) spectrum.

The UV-visible spectrum showed the disappearance of bands at ~520 nm and ~760 nm, attributed to Mn^{3+}-Ti^{4+} and Fe^{3+}-Fe^{2+} intervalence charge transfer (IVCT), respectively. New bands appeared at ~320 nm and ~445 nm after heating at 550°C, associated with Mn^{2+}-Ti^{4+} and Fe^{2+}-Ti^{4+} IVCT, respectively. That means the reduction of trivalent cations into divalent cations was reported when heated at 550°C. In addition, the reduction redox reaction of Fe^{3+} and Mn^{3+} cations was verified by FTIR spectroscopy as well, which revealed increased intensities of the heated spectrum at 3720 cm^{-1}, 3610 cm^{-1}, and 3665 cm^{-1}, corresponding to Fe^{2+} and Mn^{2+} ions. The reduction of band intensities of UV-vis and FTIR spectrums relates to trivalent cations, and the increase of intensities corresponding to divalent cations after the thermal treatment reveals that reducing atmospheric conditions created at 550°C caused colour shifting from brown towards orangish yellow colour within the studied samples with some increase of darker appearance along that polarization direction.

The preliminary study results revealed that significant colour change occurred at 550°C, whereas higher temperatures (650°C and 750°C) resulted in less pronounced colour transformations. Although heat treatment at 550°C effectively enhanced the colour, the darkness of the samples remained a challenge. Prolonged heat treatment at this temperature is suggested to achieve further lightening and a desirable reddish hue, adding value to the gem quality of Sri Lankan dravite tourmalines.

Keywords: UV-vis spectroscopy, FTIR spectroscopy, GIA colour grading, Brown tourmaline

SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT OF THE GEM INDUSTRY IN RATHNAPURA AND MONARAGALA DISTRICTS

D. L. Dasanayaka*, S.W. Nawarathna, H.H.D.A.L. Siriwardena

Postgraduate Institute of Science, University of Peradeniya, Sri Lanka.

**Corresponding author: luxdasanayaka@yahoo.com*

Socio-economic and environmental impacts due to gem mining and related activities are increasing rapidly in Rathnapura and Monaragala Districts. Due to the lack of research on the Socio-Economic and Environmental effects of gem mining in the areas where it occurs, the relevant parties have been under no obligation to mitigate the adverse effects. Therefore, the main objective of this case study was to identify the socio-economic impacts of the stakeholders in the study areas and the negative environmental impact of the mining industry, followed by finding solutions to mitigate these impacts.
Based on field observations, a literature review and a questionnaire survey, the positive and negative socio-economic impacts and environmental impacts of mining in the study areas were identified under a four-factor conceptual framework. Direct interviews were carried out through group and individual meetings with all the categories of the mining industry in the study areas. Descriptive analysis helped to identify the main characteristics of the data collected. One sample t-test was used to determine the monthly income differences of the respondents in both districts.
Table 1 shows a significant difference between mine owners and mine workers' monthly income in Rathnapura and Monaragala districts at a 95% confidence level. The researcher found that the education and living standards of the miners were also below average compared to the mine owners, and most miners suffered from a loss of steady income. Most miners are from the low-income category, and their poverty index is very high, while most mine owners live a life of luxury. According to the research sample from the Rathnapura district, 16% of females and 84% of males are engaged in the gem industry. In the Monaragala district, only males have been involved in the gem industry.
In conclusion, this research addresses the gem mining industry's adverse socio-economic and environmental impacts. It will also help reduce poverty by

supporting the integrated sustainable development of impacted communities in the future.

Table 1. Paired Sample t-test

Paired t-test	Mean difference	St. Deviation	t-value	P-value
Between mine owners and mine workers- Rathnapura	15,3747.92	14,1708.92	3.76	0.003#
Between mine owners and mine workers- Monaragala	94,419.17	6,8392.40	4.78	0.001#

- at 95% confidence interval

As the illegal excavations for gems are not closed properly, these abandoned mines pose many accidents and various environmental hazards. Due to abounded open pits, the water accumulates and transforms into an adversely generated acidic solution while added to surface natural water resources, flowing into various agricultural lands and generating carriers of diseases such as mosquitoes. It was shown that large-scale mining and dredging along the riverbanks lead to erosion of the riverbanks, and mining operations must be stopped from time to time due to frequent floods. The researcher also observed that the remaining sand, mud and other waste associated with the mines are released into the river, which causes river water pollution.
In both study districts, it was revealed that the target growth rate of the industry could have been better due to the lack of adequate infrastructure, which was a cause for concern. Although many organisations are involved in the gem industry, it is evident that the industry needs more contributions due to more inter-communication between them. Due to weather conditions, mining disruption along the way can lead to a waste of investment and a drop in income levels. In such cases, neither public nor private banks will come forward to provide the funds and withdraw money from various individuals at high interest rates. These findings facilitate considering the possibility of banks and other

institutions supporting them. The proposed insurance compensation scheme for mine owners for non-mining periods will enable them to invest in other ventures. This research is a guide to address the negative socio-economic and environmental impacts of the gem mining industry, which will also help reduce poverty by supporting the future sustainable development of the affected communities. Moreover, the awareness of the people in the field about the use of first aid in emergencies, labour law and rights, and new technology for finding correct gem deposits needs to be improved. Furthermore, miners established an organisational structure to prevent cartel operations and underbidding in the sale of gems.

Keywords: Environmental impact, Income distribution, Miners, Mine owners,

Acknowledgement: Our sincere thanks to the National Gem and Jewelry Authority staff of the District Secretary Offices of Rathnapura and Monaragala for their encouraging support, assistance and kind cooperation was given for my fieldwork.

DIFFERENTIATING MADAGASCAR AND SRI LANKAN LOW-GRADE SAPPHIRE USING UV-VISIBLE SPECTROSCOPY

P.G.B.R.L. Bandara[a*], A.H.P.K. Seenigama[a], R.G.C. Jaliya[a], S. Illangasinghe[b]

[a]*Department of Applied Earth Sciences, Faculty of Applied Sciences, Uva Wellassa University, Passara Road, Badulla, Sri Lanka.*
[b]*Gem and Jewellery Research and Training Institute, Welivita, Kaduwela, Sri Lanka.*

**Corresponding author: booparasara@gmail.com*

Sri Lanka is famous for gemstones, especially for Ceylon Blue Sapphire. Considering the country's area, Sri Lanka is the densest gem-bearing country in the world. Geologically, around 90% of Sri Lankan land comprises metamorphic rocks. They have been subdivided into three lithotectonic subdivisions based on their lithology, structure, and age. They are the Wanni, Highland, and Vijayan complexes. The highland complex has shown the highest potential for gem origin for decades in Sri Lanka. Most of Sri Lanka's gem mining is from sedimentary deposits because they are secondary placer deposits after originating mainly from metamorphic processes. Madagascar has also been one of the largest gem-producing countries in the world. It has some similarities to Sri Lanka based on its geologic formations. The southern part of Madagascar has a metamorphic formation from the Precambrian basement, which is similar to the highland complex of Sri Lanka. But the northern part of Madagascar has originated from a volcano-sedimentary series, which causes the basaltic origin of Madagascar gemstones. This basaltic-origin corundum has the highest percentage of iron compared to the metamorphic origin in Madagascar.
Madagascar-origin gemstones are very abundant in Sri Lanka due to gem export regulations in Madagascar and gem import regulations in Sri Lanka. Therefore, Sri Lanka could continuously supply low-grade Madagascar gemstones for the local gem market. Corundum is one of the most popular gemstone categories in Sri Lanka. The corundum mainly consists of Al_2O_3. Both rubies and sapphires belong to this family. The pure corundum, without any impurities, exhibits a transparent and colourless appearance. Low-grade sapphire could appear as transparent, translucent, and whitish or semi-brownish. Low-grade sapphire has of slightly more transparent appearance rather than the Geuda varieties. Fewer

concentrations of rutile impurities are responsible for this translucent appearance of low-grade corundum than Geuda.

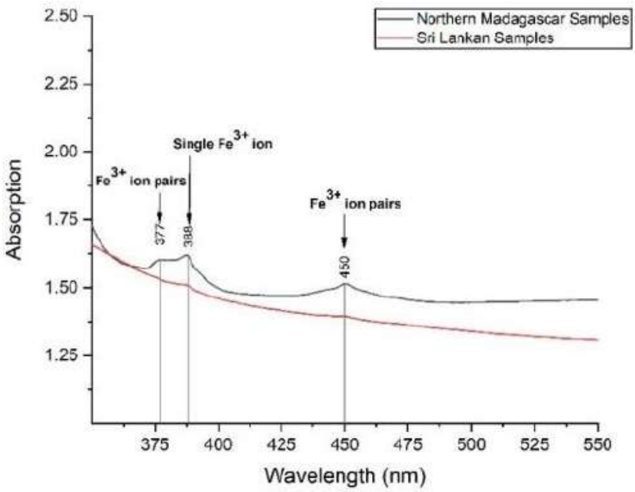

Fig. 1. UV-visible spectra of low-grade sapphire samples from the Northern part of Madagascar and Sri Lanka.

Due to the juxtaposition of Sri Lanka and Madagascar in Gondwana, the Pan-African mineralised belt runs from Antarctica through the Highland complex of Sri Lanka into Madagascar, Mozambique, and Tanzania. Therefore, sapphire gemstones, particularly those originating from Madagascar and Sri Lanka, often exhibit similar characteristics, making their country of origin challenging to discern. While existing analytical methods provide some basis for distinguishing these origins, their precision and reliability must be clarified. To overcome these issues, combined analytical techniques are frequently employed. This research aims to investigate the potential of UV-visible spectroscopy as a reliable method for differentiating between Northern Madagascar and Sri Lankan low-grade sapphires. Thirty-eight low-grade sapphire samples, 19 from the Northern part of Madagascar and 19 from Sri Lanka were subjected to UV-visible spectroscopy analysis. This research used the random sampling technique in relevant areas for sample collection. After careful preparation, including faceting and 1M

hydrochloric Acid cleaning, the samples were analysed within a 300-1000 nm wavelength range using a Multiskan GO Microplate Spectrophotometer.
The results revealed a distinct spectral feature: a significant peak at 377 nm in the UV-visible spectra of most Madagascar samples. In contrast, none of the Sri Lankan samples exhibited this peak but they show other peaks which are not conclusive. Absorption bands centred at 377 nm and 450 nm indicate the Fe^{3+}-Fe^{3+} ion pairs. When two Fe^{3+} ions are sufficiently close to one another in the lattice, they function as a single entity in absorbing light, known as intervalence charge transfer. Thus, the absorption feature at 377 nm is susceptible to the concentration of Fe^{3+} ions within the crystal lattice. Therefore, the 377 nm absorption band is a sensitive indicator of the Fe^{3+} amount within the crystal. This resulting spectral difference is attributed to the higher iron content in the Northern Madagascar sapphire, which is known to contribute to the absorption band at 377 nm. This study demonstrates the effectiveness of UV-visible spectroscopy in differentiating between Madagascar and Sri Lankan low-grade sapphire. When the 377 nm peak is not displayed, the accurate origin will not be defined precisely. However, considering only these two types of origins, the presence of the 377 nm peak is evidence for low-grade Northern Madagascar sapphire, while the absence of the 377 nm peak is evidence for low-grade Sri Lankan sapphire. Thus, the presence or absence of the 377 nm peak provides a valuable tool for gemmologists and researchers to identify these gemstones' origin accurately.

Keywords: Corundum, Gem origin, Low-grade sapphire, UV-visible spectroscopy

APPLICABILITY OF GEOCHEMICAL SIGNATURE OF SEDIMENTS TO DELINEATE GEM POTENTIAL AREAS: PRELIMINARY INVESTIGATION IN NEELAGAMA, RATHNAPURA, SRI LANKA

S. Diyabalanage[a,b], S. Illangasinghe[c*], N. Jayasinghe[c]

[a]*Instrument Centre, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda.*
[b]*Ecosphere Resilience Research Centre, Faculty of Applied Sciences, University of Sri Jayewardenepura, Gangodawila, Nugegoda.*
[c]*Gem and Jewellery Research and Training Institute, Hidellana, Ratnapura.*

**Corresponding author: sillangasinghe@gmail.com*

Sri Lanka is renowned worldwide for its fine-quality gemstones. Approximately 25% of Sri Lanka's total land area is gem-bearing; however, only a few places are currently productive. The delineation of productive lands in Sri Lanka has traditionally been based on outdated methods. As a result, many gem miners waste money investing in non-productive lands, leading to significant financial losses. Additionally, mining in these areas often causes severe environmental damage without yielding gemstones, which has hindered the growth of the Sri Lankan gem industry. Previous studies have shown that the geochemistry of Rb, Ba, and Sr in stream sediments can delineate gem-bearing areas (Ranasinghe et al., 2005). However, this technique has not yet been applied to gem-bearing sediments. Therefore, this study aims to use this technique for gem-bearing sediments in a highly gem-potential area.
Neelagama, located in Rathnapura District of Sri Lanka is a village well known for higher gem occurrences (mainly blue, yellow, and geuda sapphires). Five to six kilograms of sediment samples were collected from seven locations within the gem-bearing sediment layer at each suspected gem occurrence site. Most recovered gemstones are in their crystal forms, suggesting the potential presence of colluvial deposits. Examination under a light microscope revealed that the sampling locations contained abundant minerals such as tourmaline, quartz, spinel, garnet, and geuda varieties. After drying, samples were sieved, and <63 µm fraction was used for the chemical analysis. Approximately 50 g of the selected fraction was ground using an agate mortar and pestle for energy-dispersive X-ray fluorescence (ED-XRF) analysis using the Rigaku ED-XRF

instrument. About 0.5 g of the sample was acid-digested using a Mars 6 microwave digester with EasyPrep-Plus high-pressure vessels. The content of fifty elements, including trace and rare earth elements (REE), were analysed using an Inductively Coupled Plasma Mass Spectrometer (Thermo ICap-Q, Thermo-Fisher Scientific Inc., Berman, Germany) under standard operation conditions. Interrelationships between elements and their link to the geological processes were determined using Spearman rank correlation coefficient matrices calculated using ED-XRF data. Element pairs of Ba: Zr, Ba: Co, Nb: Cr, Nb: Sr, Th: Ba, Ba: Cu, Cu: Th, Rb: Zr, Rb: Th, Rb: Cu, and Rb: Ni showed higher correlation coefficients (> 0.75). The results of ternary plots (Fig. 1) correlate with those denoted by Ranasinghe et al., 2005, which can be used to discriminate gem potential areas.

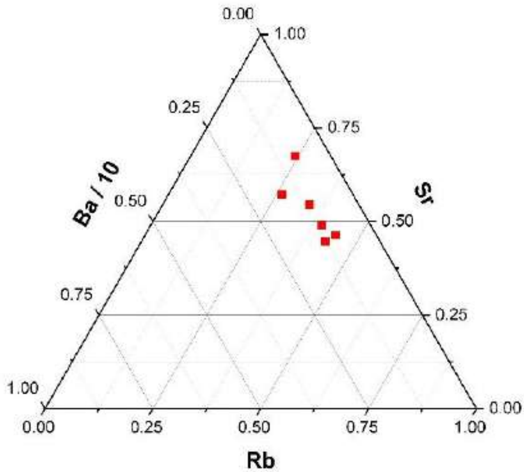

Fig. 1. Ternary plot of highly correlated elements.

The ICP-MS results of trace elements show a high content of Ti (0.92-2.09 g/Kg) and Fe (6-72-22.76 g/Kg). Moreover, other elements content of Li, V, Cr, Mn, Co, Ni, Cu, Zn, Ga, Ge, Rb, Sr, Y, Zr, Sn, Ba, La, Ce, Pr, Nd, Sm, Gd, Pb, and U are range 0.77-10.3, 20.4-40.3, 31.6-61.00, 70.6-180, 2.11-6.91, 17.4-101, 6.21-378, 23-347, 15-54, 33.7-100, 0.52-452, 2.52-42.2, 2.60-22.4, 8.91-25.5, 41.3-54.1, 9.96-26.8, 39.2-217, 84.6-458, 11.1-53.6, 39.3-198, 5.79-321, 10.3-189, and 2.26-18.8 mg/Kg respectively. According to Ranasinghe et al. (2005), the Rb×Ba/Sr^2 values greater than four and Rb/Sr values greater than 0.65 indicate high gem potential, while Rb×Ba/Sr^2 values less than one and Rb/Sr values less than 0.25 indicate non-gem potential. They further reported that the Rb×Ba/Sr^2 value is more effective for delineating gem potential. All the present study samples showed Rb×Ba/Sr^2 values ranging from 0.43 to 2.74 and Rb/Sr values ranging from 0.36 to 0.96. Even though none of the samples have the required Rb×Ba/Sr^2 values, the data clearly emphasised that this gem-potential area aligns well with the Rb/Sr values, as all samples have values above 0.25, including four locations with values > 0.65. These findings demonstrate the potential to delineate gem-bearing areas based on gem-bearing sediments' Rb, Ba, and Sr content. However, further analysis of additional samples is required to determine the most suitable indicator-whether Rb×Ba/Sr^2 or Rb/Sr values for identifying gem potential in these sediments. Additionally, establishing reference values for Rb, Ba, and Sr specific to the study area is essential to demarcate gem-bearing zones.

Keywords: Geochemical exploration, Rare earth elements, ICP-MS

Author Index

Jewels 2024 - International Gems and Jewelry Trade Exhibition and Competition

The Gemmologist Association of Sri Lanka (GASL) is pleased to propose the organisation of a Jewels Gem and Jewelry Trade Exhibition at the Ramada, Colombo. This exhibition aims to showcase the rich heritage, craftsmanship, and diversity of Sri Lankan gems and jewellery. It also provides a platform for industry stakeholders to connect, collaborate, and expand their market reach.

Objectives of the Exhibition

- Promote Sri Lankan Gems:
  Highlight the quality and diversity of Sri Lankan gems and jewellery.
- Facilitate Networking:
  Create opportunities for local jewellers, gem traders, international buyers, and investors to network.
- Enhance Industry Knowledge:
  Provide educational seminars and workshops on gemology, jewellery design, and market trends.
- Boost Tourism:
  Attract tourists interested in purchasing authentic Sri Lankan jewellery.
- Attract International consumers for the Gem & Jewelry market:
  Ability to develop an international consumer base for the Sri Lankan gem & Jewelry industry
- Development & promotion to both Tourism & Gem & Jewelry sector:
  There is a great opportunity to attract international consumers with high buying capacity & with exploring the beauty of Sri Lanka; this will become a win-win situation for both sectors.

Gem And Jewelry competition

A competition to recognise the best designs and craftsmanship in the jewellery industry.
A: Fine Crystal of high Gemmological interest
B: Best Fashioned Gem (Facetted, Cabochon or Concaved)
C: Lapidary Art (Facetted or Carved)

D: Gem Studded professional Jewellery
E: Photographs related to Gemmology or Gem Industry (minimum size 10 x 12 inches)
F: Best Jewelry art design

Diploma Awarding Ceremony
A ceremony to award diplomas to students of the D-Gem course.

Jewels Talk
An eminent lecture series featuring distinguished local and foreign gemologists to enrich the participants on the industry's latest

Jewelry Fashion show
A glamorous runway show featuring local models and designers highlights the latest jewellery trends and sets trends for the jewellery and fashion industries. Work with fashion schools and local jewellers to create stunning outfits paired with jewellery.
Promote brands and attract potential buyers, retailers, and media attention.

Expected Outcomes of the Exhibition
The outcomes of this exhibition are anticipated to be significant:

- **Increased Sales Opportunities**

Exhibitors can directly engage with potential buyers leading to immediate sales and long-term business relationships.

- **Knowledge Sharing**

Attendees will leave with valuable insights into industry best practices through workshops that can improve their business operations.

- **Enhance the quality of the gems and jewellery**

Gem and jewellery competition will enhance the support quality and value of the production

- **Tourism Growth**

By showcasing the beauty of Sri Lankan gems and jewellery, we expect an increase in tourism related to gem purchases after the exhibition.