Gem Resources In Sri Lanka

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Introduction

Gem resources of Sri Lanka are well known throughout the world for their wide varieties of gemstones. Around 20% of the total land area of Sri Lanka is reported to be potentially gem-bearing. This makes Sri Lanka possibly the densest gem bearing country in the world1. According to statistical data published by the Department of Census and Statistics, gems are responsible for about 80% of the total annual mineral based foreign income of Sri Lanka in recent times.

Geology of Sri Lanka

The geological terrain of Sri Lanka consists mainly of 90% of Precambrian metamorphic rocks, 10% of Jurassic, Miocene and Quaternary sedimentary formations, and a very minor amount of igneous rocks.

The high grade Precambrian metamorphic basement of Sri Lanka is mainly subdivided into four major lithotectonic units namely Highland Complex, Vijayan Complex, Wanni Complex and Kadugannawa Complex (Fig.1) which lithologically, geochemically and geochronologically differ from one another 2.

The Highland Complex (HC) consists mainly of charnockites, quartzites, marbles, garnetiferous gneisses and granulites, mixed with a variety of igneous intrusions. The amphibolite grade gneiss terrain of the Vijayan Complex (VC) consists of a variety of gneisses and granitoids. The boundary between the Highland Complex and the Vijayan Complex is rather well defined as shown by their differences in metamorphic grades, structure and the isotopic ages.

The Wanni Complex consists predominantly of scattered relics of supracrustal rocks and meta-igneous rocks of granodioritic gneisses.

The subordinate division of Kadugannawa Complex is exposed in the cores of six elongated, upright, doubly plunging synformal basins or 'Areans' and in one intervening antiform in the Kandy area3,4. Structurally these arenas overlie the gneisses of the Highland Complex. They consist mainly of biotite hornblende and biotite gneisses together with concordant amphibolites, quartzo-feldspathic and pelitic gneisses and metaquartzites.

Out of these four complexes, only the Highland Complex (referred to as HC, hereafter) is considered to form gems. HC is composed of metasedimentary rocks having proper chemistry for the formation of gem minerals.

Distribution of gem deposits in Sri Lanka

According to the formation, gem minerals can be categorized into four types namely, Igneous, Hydrothermal, Matamorphic, and Sedimentary.

Gem bearing beds have been classified into three types as residual, eluvial and alluvial. These three types are recognized based on their occurrence in the geological formations5. Residual gem deposits are developed on their source rocks, formed as a result of weathering and subsequent concentrating, and are characterized with presence of feldspar grains, angular rock fragments, and with gem type minerals of garnet, spinel, corundum, tourmaline, zircon and apatite, preserving their crystal shapes. Eluvial gem deposits are situated on the hill slopes, just below the source rock region of the primary gem minerals, and formed as a result of combined processes

of weathering, gravitational movement, and then by deposition in surface traps by preventing further transportation due to their heaviness. They are characterized by angular rock fragments, unsorted sand, together with heavy minerals and gem minerals conserving their crystallographic outlines. Alluvial gem deposits have been formed as a result of weathering, hill slope transportation, fluvial transportation along the sloppy rivers, and then deposition of them on flat terrains. These deposits are mainly found in ancient river beds, ancient flood plains, and present flood plains. There are five major gem fields in Sri Lanka, namely, Ratnapura, Elehera, Bibile, Okkampitiya, and Kataragama (Fig.1).

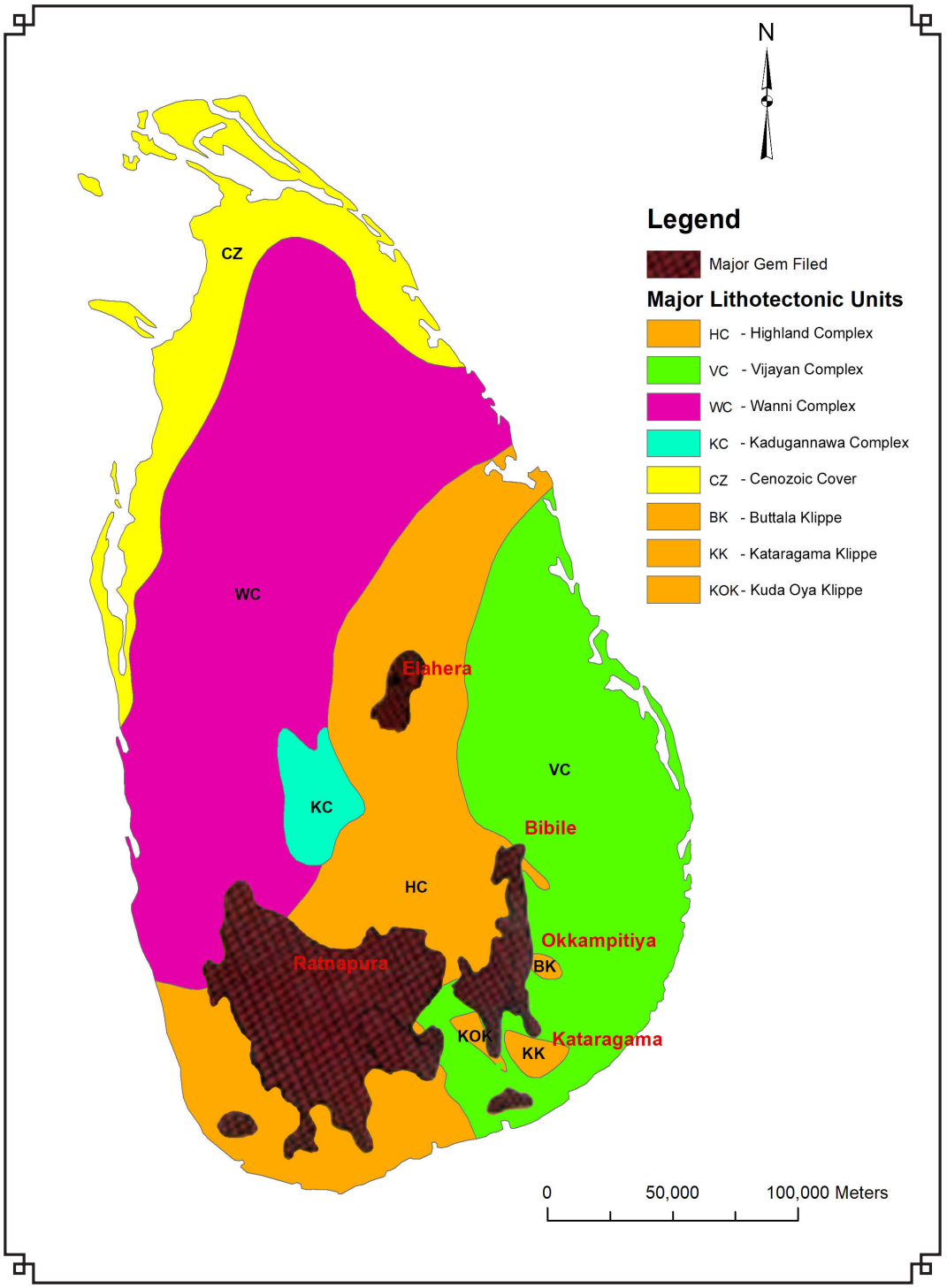

Fig 1 : five major gem fields in Sri Lanka, namely, Ratnapura, Elehera, Bibile, Okkampitiya, and Kataragama

Around 70 gem varities/families have been found in Sri Lanka. These include corundum, chrysoberyl, spinel, beryl, topaz, zircon, tourmaline, garnet, quartz, feldspar families and several other rare gemstones6. They are categorized into two broad groups, namely precious and semi-precious varieties. Corundum (sapphires and rubies) and chrysoberyl are commonly considered as precious gemstones, while spinel, beryl, topaz, zircon, tourmaline, garnet, quartz, and moonstone (Fig.2) are considered as semi-precious gemstones. Corundum is an aluminium oxide mineral (Al_2O_3), and it includes ruby which is red in colour, as well as sapphires of other colours such as blue, yellow, pink, orange and colorless etc. They are mainly found in Ratnapura, Elehera, Buttala, Kataragama, Rakwana, Hanguranketha, Nuwaraeliya, Hatton,

Awissawella, Haputale, Horana, Morawaka, Ambalantota, Galle, and Matara areas.

Chrysoberyl is a beryllium aluminium oxide mineral ($BeAl_2O_4$). There are two varities, namely, alexandrite and cat's-eye. They are found in Ratnapura, Rakwana, Elahera, Horana, Awissawella, Panadura, Haputhale, Aluthgama, Yakkalamulla, Morawaka, Galle, Matara, and Ambalantota.

Fig 2 : precious gemstones, while spinel, beryl, topaz, zircon, tourmaline, garnet, quartz, and moonstone

Spinel is a magnesium aluminate mineral ($MgAl_2O_4$). They are variable in colour such as red, orange, yellow, green, blue, and black. Spinels are common in gem bearing gravels, and are found in Ratnapura, Elahera, Nilgala, Awissawella, Hatton, Nuwaraeliya, Passara, Horana, Haputale, Buttala, Aluthgama, Rakwana, Kataragama, Morawaka, and Ambalantota.
Beryl is a beryllium aluminium silicate mineral ($Be_3Al_2(SiO_3)_6$). Aquamarine is a gem of the beryl family, which is found as a fairly common constituent of the gem bearing gravels. It is found in Awissawella, Horana, Ratnapura, Haputale, Rakwana, Morawaka, Ambalantota, and Galle.
Topaz is a aluminium fluorosilicate mineral ($Al_2SiO_4(F_2OH)_3$). It can be in various colours such as red, pink, purple, yellow, yellow-gold, orange, orange-pink, brown, sky-blue, blue green, or colourless. These are found in Matale, Ratnapura, Hatton, Passara, Horana, and Haputale.
Zircon is a zirconium silicate mineral ($ZrSiO_4$). Its colour can be brownish or reddish orange, yellow, or colourless. These are found in Ratmapura, Elahera, Nilgala, Awissawella, Nuwaraeliya, Passara, Horana, Haputale, Aluthgama, Rakwana, Matara, Morawaka, and Ambalantota.

Tourmaline is a borosilicate with a complex and variable composition. Its colour can be pink, green, dark green, peach, purple red, blue, blue green, yellow, black, bi coloured, multi-coloured or colourless.
It is a common constituent of gem gravels, and are found in Ratnapura, Nilgala, Awissawella, Passara, Horana, Haputale, Buttala, Rakwana, Morawaka, and

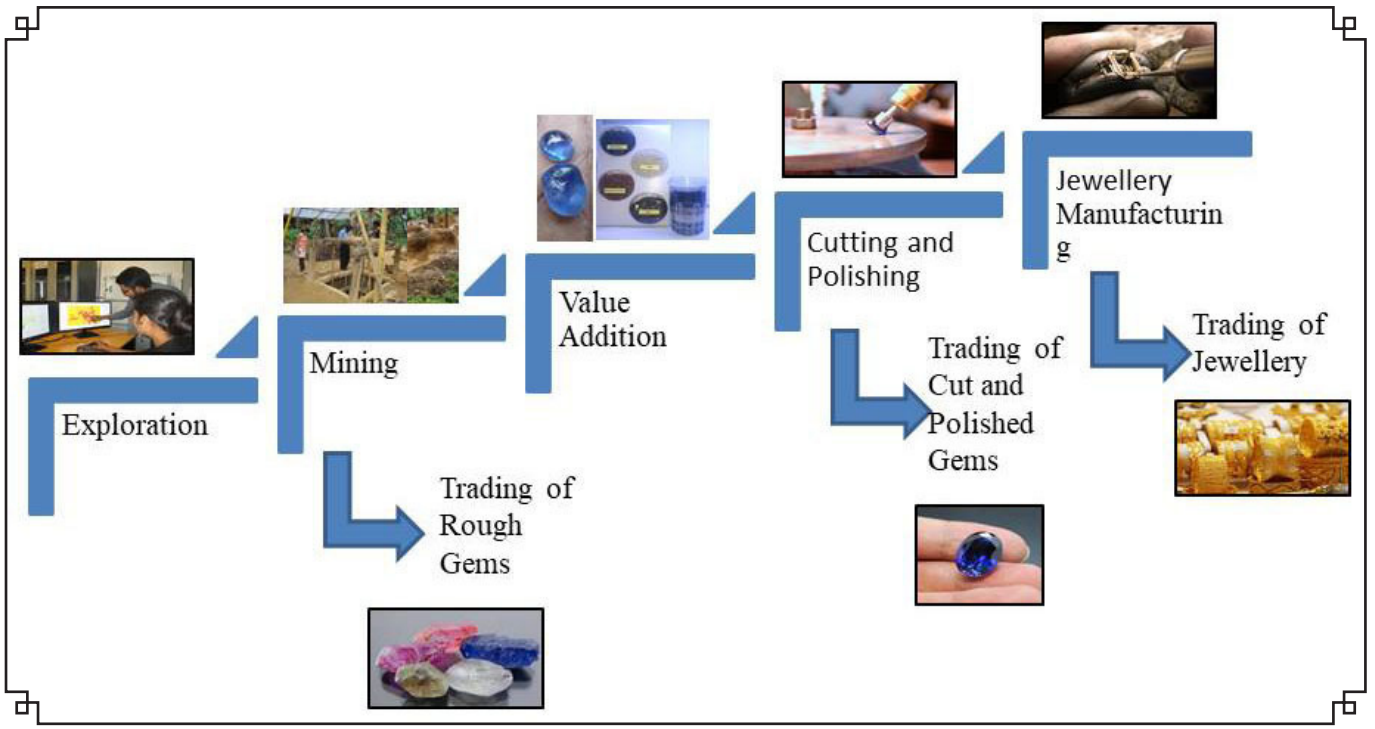

Fig 3 : Gemstones value chain consists of Exploration, Mining, Value Addtion, Cutting and Polishing, Jewellery Manufacturing and Trading

Ambalantota.
Garnets are complex aluminium silicates. They vary widely in chemical composition, and exhibit a variety of colours which may be red, pinkish or purplish red, white, yellow, yellow-orange, orange, green, brown, and black etc. They are found in Ratnapura, Elehera, Polonnaruwa, Nilgala, Awissawella, Hatton, Passara, Ratnapura, Haputale, Buttala, Rakwana, Timbolketiya, Morawaka, Ambalantota, and Matara.
Quartz is a silicon oxide mineral (SiO_2). The water clear and colorless variety is known as rock crystal, while amethyst is purple or violet, rose quartz the pink, and citrine the yellow. It is found in Ratnapura, Awissawella, Nuwaraeliya, and Kandy.
Moonstone is a potassium aluminium silicate ($KAlSi_3O_8$), which is a variety of orthoclase feldspar. It has a characteristic bluish white or milky adularescence. It is found in Kandy, Matale, and Meetiyagoda.
In addition, andalusite, cordierite (iolite), diopside, fluorite, apatite, konerupine, taaffeite, saffhirine, sinhalite, ekanite, enstatite, fibrolite, phenakite, scheilite and scapolite are found as rare gem minerals within gem gravels.

Gem industry in Sri Lanka and its sustainability
Gemstones value chain consists of Exploration, Mining, Value Addtion, Cutting and Polishing, Jewellery Manufacturing and Trading (Fig.3)
Due to the following constraints, this value chain has not been functioning well and consequently this industry has been affected.
•Lack of a proper assessment of the gem resources of Sri Lanka.
•Lack of capital
•Lack of access to the international market
•Lack of access to modern technical support and resources
•Insufficient knowledge in the nature of deposits
•Skills gap
•The vast gaps in gemstone value chain
•Regulatory restrictions and inconsistent policies
•Absence of attractive tax system for private investors
To overcome these hitches, the following strategies can be executed to ensure a sustainable gem industry.
•Undertaking grass-root level exploration in search of high-quality deposits.
A systematic exploration programme should be conducted to identify and assess economically viable gem deposits in the country.
•Financing
The banking and related sectors should be encouraged to extend loans and other financial instruments to the gem and jewellery industrialists.

•Elevating technology
It is necessary for capacity building of R&D institutions in Sri Lanka, and for the expansion of technical service networks such as to quality control, common facilities for instrumentation, testing, and calibration.
•Introducing value added products to the market
In terms of the gaining the highest yield, the raw gem mineral should be transformed to gem studded jewellery, which can either be utilized locally or exported.
•Business development services
Services such as advice, guidance on technology, product quality, marketing must be provided.
•Bridging the gaps in the gemstone value chain
The linkages in the gemstone value chain (Fig.3) should be optimized.
•Improving the existing operations in the gem and jewellery sector
It is necessary to move towards higher technological advancements, increased efficiency and productivity, and move into more value-added products.
•Equip with skilled workforce
High-quality human resources with expertise in the sector, and a skilled labour force are necessary. Hence, vocational training and secondary education should prepare prospective employees.
•Policy Reform
Mines and Mineral Act needs to be revised after studying policies of successful mining nations.
•Fiscal Reform
Fiscal reforms are needed for improving public financial management, introducing a simplified tax system, increasing public and private investments, addressing infrastructure constraints and improving competitiveness. In addition Sri Lanka should revise the taxation regime, and look for more sustainable sources of growth to maintain the tax to gross domestic product (GDP) ratio.
•Prevention of environmental issues
It is necessary to facilitate environmental impact assessment (EIA) requirements of industrialists by providing technical advice and testing services especially at regional levels.

Contributions of Gem and Jewellery Research and Training Institute for the gem and jewelry industry

The Gem and Jewellery Research and Training Institute (GJRTI) is the national arm under the purview of the Ministry of Mahaweli Development and Environment for conducting research and training programmes for regulation, promotion, and development of the gem and jewellery industry. One of GJRTI's objectives is to conduct surveys on Gems in Sri Lanka. Therefore, this institute has launched a project on "Exploration and Assessment of Gem Deposits of Sri Lanka" to identify in-situ places of gem deposits, for developing a gem potential database including maps, to introduce eco-friendly mining methodologies, and to prepare guidelines for sustainable gem mining operations in Sri Lanka. Currently, it is being implemented in several districts and some gem potential maps have been finalized.

As another objective, this institute conducts research on color enhancement of gemstones. Recently researches were able to find possible colour enhancement techniques for low gem quality gem minerals such as Kirikottara, Zircon, Young Geuda, Topaz, Feldspar etc through heat treatment, epitaxial growth, and nano-technologcal methods. Further, this institute conducts research on innovative products with use of other special properties of gem minerals. Recently, it has been possible to introduce innovative products such as water filters, therapeutic products, and durable clay pots.

On the other hand, this institute also conducts training progammes such as gem cutting, jewellery manufacturing, gemology, jewellery design, colour enhancement of gems, gem carving, casting and electro plating at NVQ levels for generating a skilled labour force for the industry.

In addition to that, the institute provides technical services, technical advice and state-of-the-art laboratory facilities for the sector. GJRTI continues educating the community through workshops, seminars, and publications.

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