Geo-Pol. Sci., Med. Geol. and Urban Geol. 2019, Vol.15, p.17 - 21
Report: Received 25 May 2019 ; Accepted 14 Jun 2019

The gemstone and jewelry industry in Thailand: a brief report on the changes and challenges from upstream to downstream*

Rouay LIMSUWAN[1]

1: World Gemstone Exploration & Mining Consultant Company Limited 1368, Charoen-Krung Road, Bangrak, Bangkok, Thailand, 10500
e-mail: worldgemcorouay@hotmail.com

*Partly presented at "CCOP Workshop on the Future of ASM and Local Communities"
4 March 2019, Novotel Samui Resort, Chaweng Beach Kandaburi,Samui Island, Surat Thani Province, Thailand.

Abstract

Thai's gemstone and jewelry industry historically has an important role in the economy of the country. This highly competitive industry has observed changes as well as problems from upstream, through midstream to downstream.

"Upstream industry" means mining to produce crude gem-bearing ore. This business environment is tough because the mining law and relevant regulations are strict in terms of social and environmental responsibility. In addition mining companies are facing a shortage of resources because of the numerous large scale mechanized operations that have arrived over the past two decades which mined out the most fertile areas of mineral deposits.

"Midstream industry" means value adding to improve the appearance of crude gem-bearing ore by heat treatment and lapidary. The business situation here is contradictory and confused by the fact that many products have been treated using complicated and non-standard techniques involving chemical additives. The true openness and transparency of basic information about the treatments is important in order to guard the credibility of the industry.

"Downstream industry" means trade and marketing of the products. Here, business was disturbed not only by serious shortages of raw materials but also by the prevalence of treated/enhanced and counterfeit gems and jewelry products on the market. Consequently, consumers should seek to receive certificates or warrantees for their products issued by a world class standard identification institute before money changes hands. Additionally, restrictions on trade launched by other trading countries often stifled business. Survival of the downstream industry channels depends on how they respond to these changes and problems and whether they can beat the global competition.

Keyword : gem gravels, gem minerals, jewelry products, mining, value adding, heat treatment, lapidary, Thailand

Introduction

Jewelry is one of Thailand's top ten export items in terms of sales volume: in recent years jewelry represented more than $10,000 million and this is continuing to grow steadily. Bangkok is an especially active gemstone and jewelry trade center in the Far East where all needs of gemstones and jewelry business investors are met from upstream to downstream. Every March and September the "Bangkok Gems and Jewelry Fair" is held. At this fair, top quality gemstones from around the world can be found as well as beautiful and delicately handmade pieces of jewelry with reasonable or cheaper prices than other cities.

Also in Bangkok, famous high tech institutes serve consumers (1) by testing and issuing certificates for their jewelry purchases; and (2) by offering gemology and identification training. A lot of vocational schools for lapidary are also available close to the jewelry trade center. This paper gives a sketch of the industry from upstream production, through midstream value adding to downstream marketing to give the readers the knowledge of the gemstone and jewelry business in Thailand..

Upstream industry: Raw material production

Geology of prospecting areas

Gemstones and semiprecious stones are found in Chantaburi, Trad and Kanchanaburi provinces where Pliocene basalt is their source rock. Ruby and blue sapphire together with their associated minerals of black spinel, clinopyroxene, magnetite, hematite, olivine, glassy sanidine, zircon, and garnet are occurred as mega crystals and are randomly found in the fine grained fresh ground mass of the basalt. However ruby and blue sapphire the most famous and valuable gemstones, are rare and it is hard to find them. Black spinel is commonly associated with ruby and sapphire throughout these provinces and thus used as pathfinder.

Two kinds of deposits are recognized for the gemstones mentioned above as economic targets. "Shallow deposit" is usually found in yellowish reddish brown residual soils of weathered basaltic rock. Sub-angular to sub-round shapes of black spinel and sapphire indicate that they were not transported far from their source rock. "Deep deposit" is seen as secondary deposit of alluvium (stream placer) around tributaries in catchment areas where source rock is distributed. It is gem-gravel bed and lies about 2m-5m or more beneath the

surface with thicknesses between about 2m-3m or more. Usually their level is lower than the underground water table.

Exploration drilling

Proper deep sampling is the first step for entrepreneurs to reduce the high risks of the mining business. Drilling is an important way to obtain geological information beneath the ground such as mineralization, deposition, character of ore, value of ore, volume of ore, nature of the country rocks, structural control, etc.

Forming a test pit by hand is safe, simple and efficient and is used for exploration in the "shallow deposits" where the overburden soil is firm and dry. But in "deep deposits" this method is not suitable because ground water discharge cannot be controlled and this results in a high risk of wall-rock collapse. Thus hand operated "Bangka drilling (Empire drilling)" method was introduced for deep deposits and was frequently used. (Originally this method was designed by a Dutch manufacture for sampling alluvial tin deposits.)

At full scale of operation, Bangka drilling requires at least ten men and has a casing at diameter of 10.16 cm and a sampling bailer at a diameter of 6.35cm. Samples are removed and gathered as lumps at 152.4 cm or 182.88 cm intervals. Core samples are small in size and the minimum volume can be collected at each time. Usually the drilling rate of 1m/hour is attainable in friable ground but in hard rock this is very slow or impossible to operate. The suitable depth for the drilling is about 30 m.

Backhoe is also popularly utilized for shallow deposits because of its high efficiency and safety. The operation is very quick, so a pit of 3m depth can be dug in this way, logged, sampled and filled back in within half an hour. However, using Backhoe techniques to explore deep deposits is too costly and too risky because of the need to remove the thick overburden and to manage ground water problems.

In 1990, at Amphoe Bo-Phloi in Kanchanaburi province, the author replaced both of them by a percussion drilling machine, locally termed as "Bore Pile drilling" which is much more efficient and accuracy is logged as higher. The operation needs only 4-5 workers. The most important aspect of Bore Pile drilling is the hammer unit which is driven by compressed air, so it can operate quickly and continuously regardless of ground conditions. The drilling rate is about 1m/hour and the suitable depth for the drilling is about 30m. Bore pile drilling's damage to the surface area is small and the pits can be easily filled in after the operation is completed. Drilling costs are usually about half those of Bangka drilling. Furthermore it can be conveniently used as semi production drilling machine (Limsuwan, 2003).

Three sizes of casing and sampling bailer can be used: (1) casing at a diameter of 35cm with the bailer at a diameter of 30cm (2) casing at a diameter of 50cm with the bailer at a diameter of 45cm or (3) casing at a diameter of 70cm with the bailer at a diameter of 60cm. Appropriate selection of casing and bailer gives extremely good results in collecting samples which vary in size from clay particles up to boulder size. The samples can easily be collected in large quantities and more details of logging can be done than with the obsolete methods.

Mining operation

For more than a hundred years, gemstone deposits in Thailand were manually mined using primitive pits, shafts and small trenches. Later "wet mining" was employed. This method is called "wet" because of the usage of centrifugal gravel pump which sends high pressure water through a nozzle. They shoot this to break weathered residual soil and/or gem gravels and send the materials down along a slope to a lower level where a gravel pump sucks and send them to a sluice box and/or grizzly screen.

The large-scale mechanized "dry mining" was also employed by using backhoe excavators and dump trucks to remove overburden and to throw it away in dumping areas. Once unconsolidated gem gravels were reached, these were excavated and transported by trucks to ore processing plants. Although centrifugal pumps do not play a major role, they are still used for draining groundwater in open pits.

In order to minimize their investments, some companies do not use dump trucks but instead use hybrid methods between dry and wet mining to attain high practical efficiency. Gem gravels are fed into mobile "rotating screens" or "grizzly screens" which are set up on pit floors. Boulders, gravels and needless sediments are thrown away on pit floors whereas gem gravels are sent to screens for classification. Gemstones and gravels are then sorted into similar sizes and deposited into ponds where gravel pumps suck and send them to processing plants which are usually built on the bank of open pits.

Over the last two decades, large-scale mechanized mining together with voluminous processing methods exhausted most of the gem-mineral reserves in the country. Now they are facing a serious shortage of gem resources and most of the mining companies are operating outside the country.

Mineral processing Plan

Generally speaking, sluicing has been popular for washing, sorting and separating uneconomical portions of mined products in artisanal and small scale mining (ASM) around the country. In sluices, coarse-grained material and gemstones are trapped at the bottom while barren sand, silt and clay are left as tailings in drainage. The crude gemstones obtained are picked out by hand. Recently the author modified a concrete mixer (the type commonly used in construction work) to be applied in the ASM process. The result showed that washing, sorting and separating

can be done for larger quantities in a shorter time and the recovery rate is higher than with the sluice boxes (Limsuwan, 2011).

At standard mechanized processing plants, gemstones and associated heavy minerals are treated respectively as follows:

(1) The obtained gem gravels are fed into ore bins.

(2) High-pressure water jets are applied through nozzles to roughly crush gem gravels and send them down to a series of rotating screens which separate unwanted sizes of gravel. The mesh size of the rotating screens can be selected depending on the size of the material. Slurry that passed through screens is sent to a sorting jig which is installed at a lower level.

(3) Sorting jigs use a gravity technique to sort out gemstones and associated minerals in the slurry. Slurry is treated by the jig floor screen by using a plunger mechanism to provide pulsation. Lighter particles are brought to the top and remain there; heavier particles are collected on the bottom and driven off into launders under gates. Lighter particles are carried out of the jig by the overflow. Small-sized particles which pass through the screen are known as "hutch product" or "underflow". In the lowest level of the sorting jig the last hutch product and their overflow slurry are left as tailings.

(4) Gemstones in the final concentrate are classified by hand according to their grade and grain size. Actually, manual hand picking is uncomfortable to operate continuously for long hours and many workers pilfer precious minerals. Because of this problem photometric sorting is introduced. This equipment requires only one or two operator(s) and can improve efficiency of the recovery.

Environmental Impact Assessment

In Chantaburi, Trad and Kanchanaburi provinces, mines are still operating on low-grade ore in open pits. Dust arises from the pits during mining and from roads during the transport of crude products by dump trucks. Since dusts may contain elements which are associated with health problems, they are suppressed by spraying water. In mechanized processing plants, they do not add any chemicals to the products, and thus the washing, sorting and separating operations produce only muddy water. Suspended materials in the water are precipitated in several ponds which are constructed in tandem. Part of the clean water from the last pond is recycled and the rest is released to streams near the ponds.

Rehabilitation of landscape

The government of Thailand strictly requires local owners of natural resources to reach optimal standards with respect to sustainable development in their mines. Landscapes have been renovated to result in sites of varying use with environmental care such as agricultural farming land, orchard gardens, fish and shrimp culturing ponds, traveling resorts and standard golf courses.

Midstream industry: Value adding process

History of heat treatment

Mediocre gemstones can be changed into commercial ones when they are put under intense heat and are altered in color. The effect was discovered by accident: jewelers in Thailand noticed an effect when a large building was burnt in 1968 in Chantaburi province because the big fire changed low quality gemstones into ones with better color and clarity. They then started heating experiments and found that a year later they could get satisfactory products. Such treatment became common in the world because color and clarity of treated gemstones are usually sustained. All of the heated crude gemstone is indicated as heat treated in the qualification and certification warrant.

Inclusions in groundmass

"Inclusion" refers to any foreign body, whatever its origin, enclosed within a substance, such as liquid or small crystals of one mineral in another, air or gas bubbles in glass or synthetic stones visible to the unaided eye or with a magnifier only (Shipley, 2010). For example blue sapphire is blue in color because of titanium and iron inclusions. Different Ti to Fe ratios give sapphire different tones of the said color. Red ruby has chromium and iron included to cause the hue. Other examples of inclusions responsible for a gemstone's color are zircon, rutile, monazite, xenotime, alkaline feldspar, chlorite, pyrite, mica etc. Heat treatment is a process to change the oxidation state of those inclusions to cause hue and saturation of the host gemstone.

Different locations produce different types and ratios of inclusions and heat treatment has to be repeatedly undertaken until satisfactory results are obtained. Once success is achieved, the process becomes a business secret of the owner. Today you can send your crude gemstones from any sources around the world to Chantaburi or Bangkok in order to add value with heat treatments.

High temperature Furnace

Various types of high-temperature furnace are used in Chantaburi. Usually they build furnaces to their own design based on their experience. The combustion chambers have different volumes of space within them and the type of fuel and burner heads used varies with each technique. Accessory pipes are connected to the combustion chamber and this is used to add other fuels, oxygen and/or other gasses to control the atmosphere in the combustion chamber during the treatment. In home factories, an efficient ventilation system is applied to eject air which is produced from the incomplete combustion of fossil fuels in obsolete furnaces. Now new high-voltage electric

furnaces controlled by computers are available. Such furnaces curb air pollution and are more cost effective.

Oxidation and Reduction

Oxidation and reduction in combustion chambers depend on the character of the gem minerals. For example, in order to change pale-blue sapphires into fresh deep-blue colors, the mineral is treated under reducing conditions using coke and/or diesel fuel. In case of ruby, high-voltage electric furnaces are used to upgrade its reddish-blue color into a fresh deep-red color under oxidizing conditions.

Stones to be treated are first coated with borax powder. Then they are put into a crucible with the lid sealed with heat resistant cement paste. Borax is an accelerator which can absorb heat and increase the temperature in minerals. They start the treatment at room temperature and then gradually increase the temperature until they get good results e.g. 1,850˚C. The duration of this task depends on the artisans who are engaged in the work. If the result is not satisfactory then they repeat the treatment.

Adding chemical substances

Conventional heat treatment of gemstones does not involve the addition of any chemicals but advanced techniques of value addition utilize some chemical substances, where the surface of gemstones is coated with a chemical powder and then heated.

It is common to apply lead glass powder to a low-grade sapphire's surface and heat it. This is to fill in fissures or cracks in groundmass and to homogenize the look of the sapphire.

Another new technique utilizes beryllium oxide. The compound is applied to the surface of pink sapphire from the Ilakaka village, a gemstone producing area in Madagascar. After heating, pink sapphire changes its color to orange. The resulting color resembles the expensive "padparascha" of Sri Lanka which is naturally orange in color and trades at high prices. However only the surface of treated sapphire turns orange in color unlike "padparascha", where the color is present throughout the whole body of the stone. For the moment there is no reliable test for this and so they can only cut or break orange sapphire to know whether its color is genuine or treated.

Downstream industry: Marketing

Thai jewelry products are included in the country's top-ten export items. Recently these products have earned more than $10,000 million per year and the profit is still growing each year. Consequently trade and marketing are important for jewelers in Thailand. Only in Bangkok do you find thousands of jewelry stores and fashion houses. Also there are at least ten gemstone laboratories that meet international standards and which serve customers around the world in Bangkok. Some institutes teach gemology and offer identification training courses for public learners. In addition many vocational training schools for lapidary are available near the jewelry trade center.

As stated above, skills of artisans are quite sophisticated, handmade jewels are stylish and the price is reasonable. However nowadays there are many heats treated and counterfeit products on the market. Therefore customers are recommended to confirm the certification or warrantee of the jewelry of interest before payment. Usually in Bangkok, customers can request testing and certification and can get this issued based on international protocols.

In spite of the history and accumulated knowhow, jewelry shops are facing challenges such as restriction of trade, environmental responsibility and shortage of raw material. For example merchants cannot bring crude gemstone from Madagascar to Thailand due to a provision of the mining law. Traceability is another important issue to maintain the credibility of the industry. Survival of the downstream industry depends on how Thai jewelers respond to the world trends and whether they can beat their global competition.

Concluding Remarks

The gemstone and jewelry industry in Thailand has observed changes as well as problems not only with technology, but also with respect to social and environmental problems.

Firstly it became impossible to exploit the land for high quality gemstones during the past two decades because of the numerous large-scale mechanized mining operations (mainly open pit). Thailand lost most of its fertile gemstone deposits and now the mining industry is facing a serious shortage of gem minerals.

Secondly rehabilitation became a mandate for the miners when digging in a mineralized area. Barren landscapes must be renovated to then be used for another business such as farming, orchards, fishery ponds, traveling resorts, home stay places and standard golf courses.

Thirdly the trading system has changed. Before Thai's entrepreneurs visited mining towns abroad to import raw gem minerals, but nowadays local diggers or owners of mineral land come over to Bangkok and sell the product by themselves.

Fourthly value adding methods have been rapidly developed. More than 95% of gem mineral produced in Thailand is mediocre and artisans had to find ways to improve the appearance of stones. Recently new advanced techniques such as lead-glass filling and beryllium diffusion are established and consumers must know that some items in shops are treated/enhanced and counterfeit products.

Acknowledgments:

First, last and always the author wants to express deep appreciation and thanks to his spiritual teachers, gemstone and jewelry entrepreneurs who are the source of everything that is in this report. The writing in this report would have been

impossible without those people.

The author is also very grateful to the Japanese Society of Geo-pollution Science, Medical Geology and Urban Geology (PMUG) who kindly edited and published this report.

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