Identifying Garnet Bearing Rocks Suitable for Mining and Processing of Manufactured Garnet Sand

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Abstract: Garnet sand has a wide range of applications in mineral industry, mainly as an abrasive. The demand for garnet sand has been increasing rapidly during recent past. Industrial quality garnet can be recovered from beach sand deposits and crushing and processing of garnet rich rocks. In Sri Lanka, there are several garnet rich beach sand deposits. However, due to negative environmental effects, mining has not been carried out for recovery of garnet from such deposits.

In this study, the objective being to identify suitable garnet rich rocks to recover manufactured garnet sand, geological map of the country was studied in detail. Out of several locations, Thanikotuwa village in Dewaladeniya GS division in Lakgala - Pallegama divisional secretariat of Matale district was selected. Detailed work was carried out in this location having 30.39% garnet recovery whereas. Garnet cut-off grade of only 15.68% is expected for a project for obtaining manufactured garnet sand only. Also in the processing stage, remaining crushed rock material can be used directly as fine aggregates in the construction industry. Economic feasibility studies show commencement of a manufactured garnet sand project including IML - A grade quarry, crushing and processing plant in this location is economically viable.

Keywords: Garnet, Crushing, Processing, Separation, Cut-off grade

1. Introduction

Garnet is the name for a group of complex silicate minerals, all with crystalline structures classified in the isometric crystal system and similar chemical compositions. The deposit of garnet can be categorized into two main types; secondary placer deposits and primary garnet bearing rock.

Garnets are used as industrial abrasive because of angular shape, relatively high hardness, durability and specific gravity. The industrial garnet values are influenced by the size and grade of reserves, the type and quality of garnet mined the proximity of deposits to infrastructure and consumers, and the milling costs.

Garnet sand has a wide use in

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industrial applications, some are ceramics and glass production, aircraft industry, blast cleaning and water jet cutting abrasives, as an abrasive blasting medium, water filtration and hydro cutting, etc. Commercially, garnet is valued for its high hardness (6.5 to 8.0 on the Mohr`s scale), and its high density (with specific gravities ranging from 3.4 to 4.2). Garnet sand can be either mined as beach sand or manufactured from garnet bearing rocks. Sri Lanka has a number of mineral sand deposits that contains garnet, such as the Pulmoddai, West coast and Southern coastline deposits. However, due to negative environmental impacts, mining has not been carried out for recovery of garnet from such deposits. Garnet bearing rocks can also be found in locations such as Balangoda, Rathnapura, Elahara, Meepe, Haputhale, Koslanda, Eheliyagoda and Wellawaya.

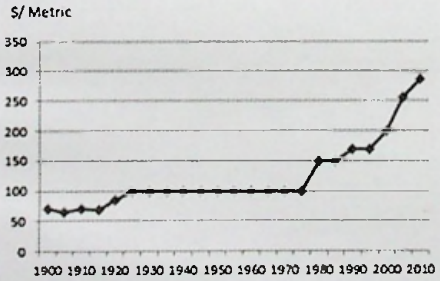

Figure 1 - Values of garnet 1900-2010

The demand for garnet has been increasing rapidly because of its wide range of applications. Figure 1 shows the unit value of garnet changing over the years. Data from mineral year book 1900-2010 (USGS, 2006).

2. Methodology

2.1 Selecting the study area

When selecting the study area the amounts of garnet present in the rock, outcrop of garnet bearing rock, quantity of garnet bearing rock and the accessibility to the location were the four major factors that are considered.

In previous studies, several locations were studied, however, in most of the locations garnet percentages were less than 15% or locations not feasible for IML – A mining (Samarakoon et.all 2013). This study proposes quarry (203722E, 270408N), crushing and processing sites are to be located at Thanikotuwa village in Dewaladeniya GS division in Lakgala - Pallegama Divisional Secretariat of Matale district.

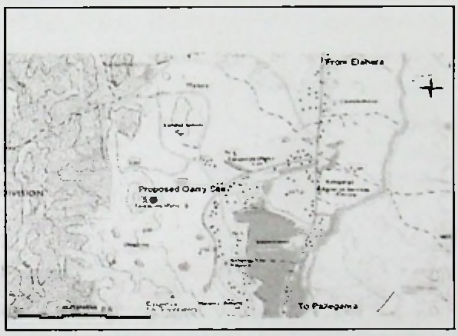

Figure 2 - Location map

The site can be accessed along roads to Bakamoona- Elahera, about 8 km from Bakamoona and, then another 6 km to Gomahandiya along Lakgala road. The final stretch is 3 km to Thorapitiya village and another kilometer to the site through jeep track. The location is in the 49 Pallegama (1:50,000) topographic map area (Fig. 2). The rock out-crops are confined to an elongated high elevated ridge, surrounded by flat ground. There is no human settlement in the close vicinity.

2.2 Field studies and sampling

Field studies were carried out in Elahara-Pallegama area. An outcrop of garnet bearing rock which was isolated from village houses was

selected for collecting samples and further studies. The location was (203722E, 270408N) at Thanikotuwa village in Dewaladeniya GS division. The position details of samples were taken by handheld GPS. Lithology and structure of the rock formation in the field was subjected to study. Three samples were selected from three locations giving due consideration to the lithology and structure of the rock formation.

2.3 Laboratory experiments

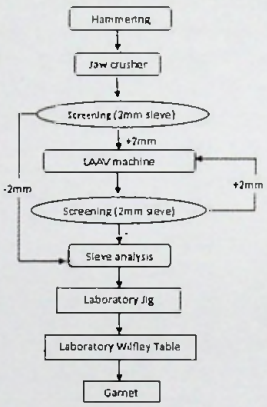

Figure 3 - Crushing & processing (Lab)

Figure 3 shows the method of crushing garnet bearing rock and garnet processing in laboratory level.

3. Results and Discussion

At first, to determine the optimum parameters of LAAV machine for crushing garnet bearing rock efficiently, series of experiments were done and optimum parameters were determined at laboratory scale (Fig.4).

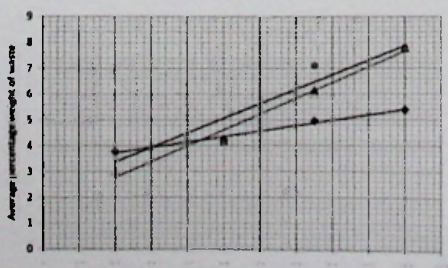

Figure 4 - Optimum parameters - crushing

The optimum number of balls is six and revolution is 80rpm.

Then 3 samples were crushed using those parameters. The separation was done using jigging machine to remove tailing first. And then using Wilfley table garnet was concentrated with an optimum angle of Wilfley table which gives the maximum recovery of garnet sand (Fig. 5)

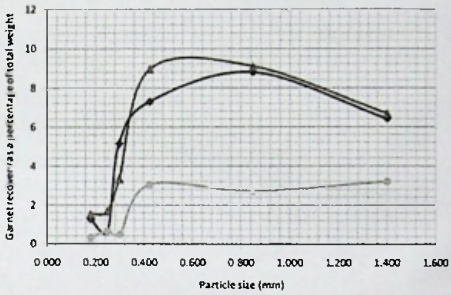

Figure 5 - Maximum recovery of garnet

Most of industrial operators employ traditional spiral classifiers for the separation of heavier garnet from lighter gangue minerals, some in conjunction with hydrosizers. Few operators use flotation methods for the separation of garnet from heavy nonmagnetic fractions. Concentrates are dried and then sorted by both high-intensity magnetic and electrostatic separators.

Simplified procedure for industrial garnet recovery is shown in Fig. 6. Industrial garnet is priced at a wide range, depending on application, quality, quantity purchased, source, and type. The current market price of garnet is based on requirement and size. To increase profitability and remain competitive with foreign imported material, production may be restricted to only high-grade garnet bearing rocks or other by products that occur with crushed rock.

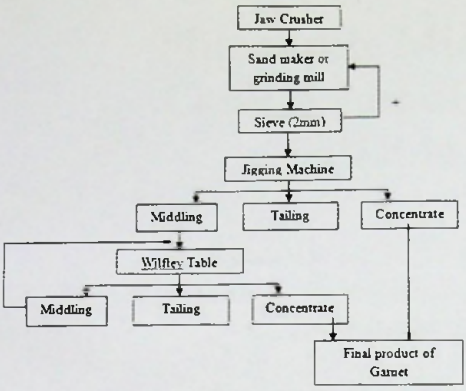

Figure 6 - Simplified procedure for industrial garnet recovery

To present, crushed material of size less than 180µm at 5%, the optimum revolution of LAAV machine and optimum number of balls must be 80 rpm and 6 balls respectively. The recoverable garnet percentage at location 1 is 29.52%, location 2 , 10.43%, and at location 3, 31.26%. There is a small amount of biotite present as well, with the final product. Location 2 sample belongs to a different band of rock having less percentage of garnet. 90% of the rock around that area is composed of the rock type presents at location 1 and 3. Therefore, location 2 can be neglected when calculating the average percentage of garnet represents that area. The cut-off grade can be determined either by considering only the garnet sand as final product or both the garnet sand and manufactured sand (by product) as final products because the 60-75% of waste product is sand size quartz and feldspar with small amount of biotite as impurity.

4. Conclusions

The rock found in the area is medium to coarse grained Garnetiferrous quartzo feldspathic gneiss. The average total garnet percentage of the rock is 30.39%. However, the amount of product obtained on the pan is higher than 5% of total weight, the amount of garnet among the waste product can be negligible. As the higher demand size is 850 - 180µm, the amount of recovered garnet is 23.84% of total weight.

When consider garnet sand only as a final product, the cut-off grade is 15.32%. However, the remaining crushed rock material can be used directly as fine aggregate in the construction industry. The average garnet percentage of the study area is about 30%. Therefore, this location is highly suitable for manufacturing garnet sand project. The total volume of available fresh rock is 1,012,500 m^3 and, the plant can be successfully run at least for 10 years from commencement.

5. Acknowledgement

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