Identification of Suitable Garnet Rich Metamorphic Rocks and Development of a Methodology for Manufactured Garnet Sand

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Abstract: Garnet has huge demand in worldwide at present. In Sri Lanka, there are few garnet mineral deposits, as beach and river sand. But rocks having considerable amount of garnet as a minor mineral are common in metamorphic terrain of Sri Lanka. The beach garnet sand deposits in coastal zone are suitable for industrial uses, but cannot be mined due to environmental problems. Thus the next possibility is manufacturing garnet sand from garnet bearing rocks. The research was carried out to identify high percentage garnet bearing rocks and development of a methodology to recover garnet sand for industrial uses. After identifying the potential areas using Geological maps, field visits were carried out for verification and sampling. Garnet separation techniques were studied and most effective techniques was used and calculates the percentages of garnet in the rock. Separation was done at laboratory level to discover the most effective method for recovering garnet from the rocks. KDESH Pvt Ltd, quarry site at Neboda had highest percentage (19%) of recoverable garnet and the rock can be recommended for use in manufactured garnet.

Key words: garnet bearing rocks, crushing(, separation, garnet sand

1. Introduction

Garnet mineral (Almandine type) has unique characteristics such as high hardness value (7-7.5), high melting point, high acid intensity, the chemical stability. Therefore, garnet has a wide range of industrial uses. Common uses of garnet in the industry are blast cleaning and water jet cutting abrasives, abrasive blasting media.Further, water filtration (Lower quality industrial garnet is used as a filtration medium in water purification systems because of its relative inertness and chemical degradation resistance), optical lens grinding and plate-glass grinding, abrasive, aircraft manufacturing industry, ceramics and glass industry, abrasive powders and loosed-grain

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electronic component manufacturing industry, motor vehicle manufacturing industry, scratch-free lapping of semiconductor materials and other metals, hydro cutting, Finishing of wood, leather, hard rubber, and plastics, In petroleum industry for cleaning drill pipes and well casings (Moyle, 1879).

Main objective of this research was to determine the effective method for recover the garnet sand from garnet bearing rocks for industrial uses. There are many advantages in manufactured garnet sand including manufacturer can control the particle sizes according to the requirements of the industry.

2. Material and Methods

Geological maps in Sri Lanka were primarily studied to identify the locations with garnet rich rocks and 1:50,000 road map of Sri Lanka to find the access roads for identified locations.

Figure 1: Location of the Samples in Meepe

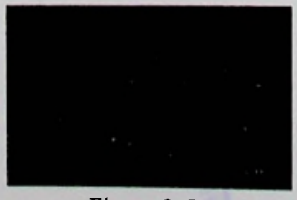

Figure 2: Location of the Samples in Haputhale – Bandarawela -

Figure 3: Location of the Samples in Neboda, Kalutara

Subsequently field visits were carried out in a three selected areas in Meepe, Haputhale-Bandarawela – Koslanda and Neboda - Kalutara in Sri Lanka.

Suitable samples for producing manufactured sand were selected from the collected samples for laboratory tests and processes. Followed up factors were considered when the suitable samples were selected; garnet percentage of the rock, suitability of the location for mining, quantity of the rocks, accessibility to the location.

For manufacturing garnet sand from garnet bearing rocks, the following methodology was used in the laboratory level.

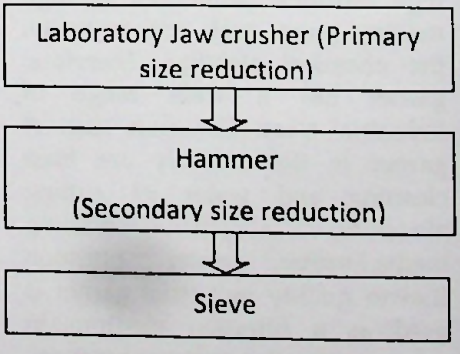

Figure 4 : Laboratory level sand making process

Viability of crushing garnet bearing rock in a large scale was checked using available quarry products from industrial crusher plants. Sieve analysis was carried out for each sample in order to analyze the recoverable garnet sand percentage from different particle sizes. Separated samples were introduced to the laboratory Wilfley table (2mm- 180µm size range only). Laboratory jigging machine was used to separate large particle sizes efficiently. As there is no demand for garnet sand below 90µm, these portions was not taken for calculations.

3. Results

Results of the garnet percentages with the sieve analysis test calculations of the selected locations are given bellow.

Location	Weight of recovered garnet sand per 1kg of (<2mm) crushed rock	Recovered garnet %
Uma oya	169.64g	16.96%
Neboda (KDESH)	197.81g	19.78%
Neboda (Metal Mix)	114.11g	11.41%
Meepe (Metal Mix)	85.6	8.56%

Table 1:Recoverable garnet percentages

Sieve analysis tests carried out for each sample. Two tests were done for laboratory level crushed sample and industrial level crushed sample for comparison.

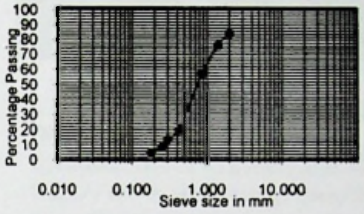

Figure 5: Sieve analysis test result of industrial level crushed sample

Three tests were carried out for three crushed sample of industrial level and average result is shown in above figure (Fig. 5). Figure 6 shows the sieve analysis test result of laboratory level crushed rock sample.

Laboratory level D_{50} value =0.45mm

Industrial level D_{50} value =0.73mm

Microscopic view of the beach garnet sand and manufactured garnet sand was taken in order to identify the unique properties of manufactured garnet sand.

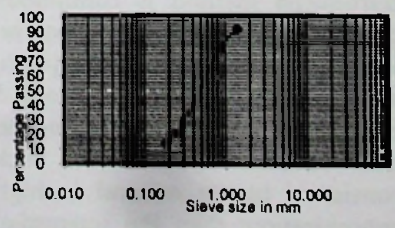

Figure 6 : sieve analysis test result of laboratory level crushed sample

Angularity of manufactured sand is higher compared to beach garnet sand (Figure 7 and 8).

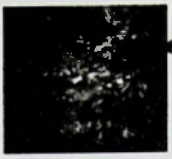

Figure7: Manufactured garnet sand

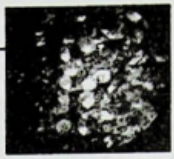

Figure 8: Beach garnet sand

4. Discussion

Table 1 shows the recoverable garnet sand percentage of the crushed rock in laboratory level. However the actual percentage of garnet in a rock should be greater than the calculated values. Because the results of sieve analysis test, considerable amount of garnet (particle size below 180µm) was removed as a waste. Fraction of the powdered rock (particle size below 180 µm) is high due to the size reduction process done in laboratory, garnet sand separation process from crushed rocks achieve a considerable level using available laboratory scale facilities.

Introduced method is continuous process, low cost, less man power, less area consumption, environment friendly method because re-usage of water and no dust emissions. But if the rock consist of biotite mineral in high concentration; then the separation process should done using separate Wilfley Tables for each particle sizes.

5. Conclusions

The sample from location (121458E, 152185N) KDESH Pvt Ltd, Quarry Site at Neboda composes of highest percentage of recoverable garnet. Rock in the area is consist of garnet granulitic rocks having high percentage of garnet is suitable for starting a manufactured garnet sand project.

Laboratory tests carried out shows Wilfley table as the best suitable method for separation of Garnet from crushed rocks.

High biotite content of the garnet bearing rock may affect the purity of the separated garnet sand. More purification can be achieved by introducing magnetic and electrostatic separators, especially for fine particles.

Due to angular shape of the particles, manufactured garnet sand is better than the beach garnet sand. Angular shape of the particles is one of unique property of the manufactured garnet sand.

A project producing only garnet sand could become a viable project if the recovery of garnet exceeds 7%. However 2% recovery of garnet is sufficient, if the project produces garnet sand and manufactured sand for construction industry.

Further studies should be carried out to evaluate the suitability of manufactured sand after separation of garnet sand from the crushed rock (by product) for the construction industry.

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