Gold Recovery from Gem Gravel

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Abstract: The combination of gold's relative scarcity and its elegant beauty has made it a very valuable commodity throughout the history of humanity. It is much evident that Sri Lanka is processing placer type secondary gold occurrences scattered with most of the alluvial gem gravel deposits in many areas. Unfortunately discards after panning for gem stones which contain finer particles of gold together with sand are thrown away as waste or sold out as a substitute to river sand. Therefore, it is important to find methods of recovering gold from gem gravel. In this study, Physical separation methods such as Table separation and Jig concentration were basically used for gem gravel as well as stream bed sediments from several parts of the country. After samples (about 300Kg) were processed, we were able to concentrate 71.2mg of gold particles and a relatively high amount of heavy minerals like Garnet, Rutile, Ilmenite, etc... Though the presence of gold in placer deposits exhibits relatively a low concentration, the high production cost in gold industry (630$ per ounce) elsewhere makes it a cheaper method to gold from gem gravel as a by-product of gem mining.

Key words: Alluvial gold deposits, Jig concentration, Table separation

1. Introduction

This research project directly addresses the hidden potential of Sri Lankan gem gravels. The idea of processing of gold from gem gravels can be considered as an economical way of gold processing since the cost of production is crucial.

Now we have even more reason to remain confident in gold mining as a safe investment, thanks to a surge in mining production costs that may help buoy gold prices for decades to come. Gold production costs swelled over 150% in five years between 2003 and 2008. Due to recent increases in energy and labour costs in the second half of 2009, experts estimate global gold production costs averaging up at $500 an ounce in the year and production costs swelling up to 660$ per ounce in 2010.

The history of gold mining in Sri Lanka can be dated back to more than 2000 years. Gold has been mined mainly from alluvial (river) sediments in the central and southern parts of the country and sediments of the Walawe

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Ganga. The main objective of our research was to determine an appropriate method of processing Gold from gem gravel and evaluating the feasibility of the Process. In the course of the work, we only aimed at physical methods for the concentration of gold particles.

2. Methodology

2.1 Defining a Suitable Sampling Technique

Suitable sampling method was selected, after the literature review of the project and the field examination was carried out.

2.2 Sampling

Gem pit was selected and the sample locations were identified so as to represent whole region of gem pit, which was followed by collection of samples.

2.3 Preparing Sample for the Gravity Separation

The samples from the field were air dried and coning and quartering method was carried out to reduce the sample size suitable for further processing. Then, samples were oven dried at 140 - 160 ^{0}C for 2 - 3 hours and weighed. Thereafter the samples were separated into three main particle size ranges to improve the effectiveness of the physical separation method. Particle size ranges were 2mm - 850µm, 850µm- 425µm and below 425µm. The over size of the 2mm was subjected to eye inspections and discarded. Other ranges were sent to gravity separators. Then, samples (500g) were taken as previously and followed a particle size distribution analysis.

2.4 Selecting the Most Suitable Processing Methods and the Sequence

The pre-prepared samples (carried out the procedure in 2.3) from "Welioya" were concentrated by gravity separators and the most suitable method was selected by analysing the result from each separator. Primary stage of sample processing must be a continuous process rather than a batch wise process (Jig). Processing with shaking table was selected for primary sample processing due to the effectiveness of the process.

2.5 The Process

The pre-prepared samples were concentrated with the shaking table. Concentrates and middlings were dried in an oven and the samples were weighed and labelled separately. Simultaneously, hand lens examinations were carried out on concentrates to recover gold particles. The concentrates which were obtained from shaking table, were sent to jig concentrator. The bottom layers from the jig were analysed with a hand lens and both portions were oven dried, weighed and labelled. Hand-lens examinations of the bottom layers reveal the presence of gold particles. Method such as Microscopic examination, reacting with HNO_3 acid, measurement of electrical conductivity, etc... were used to confirm the revealed gold particles. Then, the middling or a portion of middling (200g or 250g) from the shaking table was subjected to jigging to find heavy mineral percentage in middling portion. Finally the heavy mineral percentages were calculated by taking the sum of weights of heavier portion of middling and the concentrates from shaking table. Flow

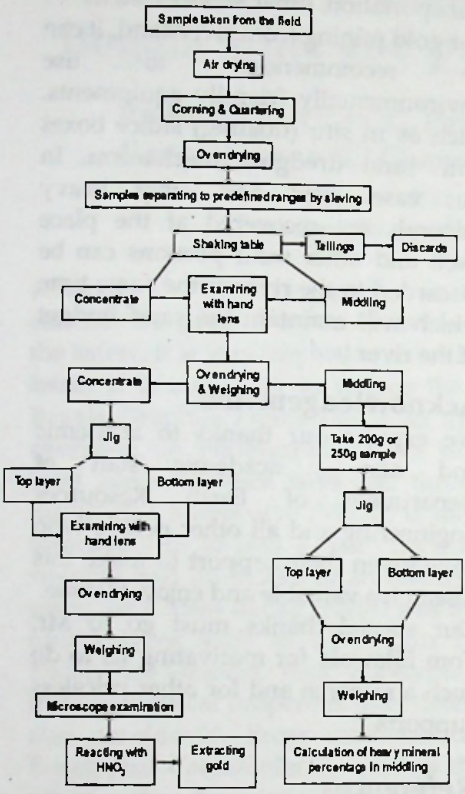

Figure 1: Flow chart

chart of the whole process is shown in Figure 1.

3. Results and Discussion

According to the results of sieve analysis tests carried out on each sample, it was evident that there was a higher portion of finer particles in gem gravel samples than "Welioya" riverbed sand samples due to several reasons, such as riverbed sand is washed continuously but material discarded from gem processing was washed only a few times as the gem processing machine enter only particles below a definite size. These particle size data will be useful for the selection and further adjustment of a physical separation method.

Gold particles were detected in bottom layer of the jig concentration as well as concentrates of the shaking table.

When detecting gold particles, there were some difficulties with other minerals due to closely similar properties. Gold particles were basically detected by examination with the naked eye and the hand lens. After detecting gold particles, they were subjected to various tests for confirmation. The tests used were Microscopic examination, Electrical conductivity and the reacting with HNO_3 acid. Electrical conductivity could only be employed on large gold particles.

Ploghophite, Pyrite and Chalcopyrite particles within initial samples cannot enter into concentrate of the shaking table due to its relatively low specific gravity (3 to 5) than the specific gravity of gold (18 to 19.5) as well as the flaky property of Ploghophite. However, those particles entering to the concentrate were positively separated into the top layer of processed concentrates at jig separator. Ploghophite can be identified effortlessly from gold pieces by microscopic examination using its flaky properties. Chalcopyrite and Gold are similar in look. Chalcopyrite can be identified by reacting with dilute HNO_3. Chalcopyrites react with HNO_3 because it contains CuS.

Considerable amount of gold particles (55.7mg) were recovered from "Welioya" riverbed sand samples and some small amount gold particles (15.5mg) were only detected from all gem gravel samples.

Recoverable amount of gold with physical separation methods are 0.5715ppm for "Welioya" riverbed sand samples and 0.0716ppm for Gem gravel samples as shown in Figure 2.

Figure 2: Gold particles

Those recoverable limits can be increased with continuous bulk sample usage and the effectiveness increased by changing parameters of the physical separation method.

Then percentages of heavy minerals in middlings of the shaking table were determined by using the jig. According to the final percentages of heavy minerals in sand samples, there were higher percentages of heavies in gem gravel samples (11.67%) than riverbed samples (5.49%). But, percentages of heavy minerals in other gem gravel samples were not in economically feasible levels considering the overall result. However, percentage of heavy minerals can vary with the location (At Bogawanthalawa gem gravel 23.39%).

According to percentage of heavy minerals, the process might be either economical or not.

4. Conclusions

It can be concluded that gold and other heavy mineral recovery may be economical with a series process of in situ gem processing. Separate processing plant with sophisticated machines may not be feasible, because discarded material of every gem pits cannot be expected to contain gold and higher percentage of other heavy minerals. It is also more costly operation considering the costs of plant installation, electricity, transportation, other services, etc...

For gold mining from river sand, it can be recommended to use environmentally friendly equipments. Such as In situ (floating) sluice boxes with sand dredging mechanism. In this case, gold and other heavy minerals are recovered at the place itself and other sand portions can be discarded to the river at the same time which will maintain the sand budget of the river bed.

Acknowledgements

We express our thanks to academic and non - academic staff of Department of Earth Resources Engineering and all other people who have given their support to make this research a valuable and enjoyable one. Our special thanks must go to Mr. Tom Ellawala for motivating us to do such a research and for other priceless supports

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