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PROCESSING OF THE GOLD ORE FROM KEDONDONG AREA, SOUTH LAMPUNG USING GRAVITY CONCENTRATION METHOD

PENGOLAHAN BIJIH EMAS KEDONDONG, LAMPUNG SELATAN DENGAN METODE KONSENTRASI GAYA BERAT

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ABSTRACT

Kedondong gold ores seem promising to be processed. Referring to its mineralogy characters, the ores can be treated by gravity concentration method that include Knelson concentrator, shaking table, jig and sluice box as well. Processing the gold sample coded A from Kedondong, South Lampung by Knelson concentrator increased the Au grade from 21.87 to 399.76 g/t. Its recovery was 91.57 %. The silver grade also improved from 287.83 to 3,427.12 g/t performing recovery of 49.65 %. Re-processing Knelson concentrator concentrates using shaking table enlarged the Au and silver grades to 1,199.28 and 5,430.80 g/t respectively. Both Au and Ag recoveries were around 89.84% and 47.45% respectively. Another sample, coded B, provided grade 165.80 g/t Au (from 8.93 g/t) and 3,275.05 g/t Ag (from 172.73 g/t) when processed by Knelson concentrator. A shaking table process for such a B-Knelson concentrate yielded the Au and Ag grades to 710,05 and 13.800,80 g/t respectively and also improved the Au and Ag recoveries to 85.56 and 85.17%. Concentrate Sample A has satisfied the requirement for final processing using smelting method, however, Sample B still needs more shaking table process in order to get satisfied condition for smelting process, namely the grade of gold >1,000 g/t.

Keywords: Kedondong gold ore, gravity concentration, Knelson concentrator, shaking table

SARI

Berdasarkan karakter mineraloginya, bijih emas Kedondong cocok untuk diolah mengunakan metode konsentrasi gaya berat yang terdiri atas Knelson concentrator, meja goyang, jengkek dan palong. Pengolahan dengan Knelson concentrator terhadap percontoh A, meningkatkan kadar emas dari 21,87 menjadi 399,76 g/t dengan perolehan 91,57 % sedangkan kadar perak meningkat dari 287,83 menjadi 3.427,12 g/t dengan perolehan 49,65 %. Konsentrat yang berasal dari Knelson concentrator diolah dengan meja goyang meningkatkan kadar emas dari 399,76 menjadi 1.199,28 g/t dengan perolehan 89,84 % dan perak dari 3.427,12 menjadi 5.430,80 g/t dengan perolehan 47,45 %. Percontoh B yang diolah dengan Knelson concentrator meningkatkan kadar emas dari 8,93 menjadi 165,80 g/t dengan perolehan 87,26 % sedangkan kadar perak meningkat dari 172,73 menjadi 3.275,05 g/t dengan perolehan 89,11 %. Pengolahan konsentrat tersebut dengan meja goyang meningkatkan kadar emas dari 165,80 menjadi 710,05 g/t dengan perolehan 86,56 % dan kadar perak meningkat dari 3.275,05 menjadi 13.800,80 g/t dengan perolehan 85,17 % . Proses akhir terhadap konsentrat meja goyang dari percontoh A dapat menggunakan metode peleburan, sedangkan untuk percontoh B masih perlu ditingkatkan lagi dengan meja goyang supaya memenuhi persyaratan peleburan yaitu kadar emas > 1.000 g/t.

Kata kunci: Bijih emas kedondong, konsentrasi gaya berat, Knelson concentrator*, meja goyang*

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INTRODUCTION

Geology of Lampung is regionally predominated by faulting and igneous rocks that connect to subduction zone. The rocks include Tertiary andesite and a number of carbonaceous-alkaline granitoid. As a result, the area is promising for epithermal gold mineralization that relates to igneous rock intrusion (Mangga et al., 1994). Gold occurs within quartz veins in Oligo-Miocene volcanic rocks of Tarahan Formation showing specific texture of vuggy, banding and crustiform along with sphalerite, chalcopyrite and manganese sulphide minerals (Crow et. al, 1994). The exploration by Apolo Gold in 2002 at Napal Umbar Picung area showed the average gold and silver contents of 19.78 and 1.096 g/t respectively. Such a figure was derived from 50 trenches and 34 shafts. Sulfide mineralization, represented by pyrite and chalcopyrite, also took place within volcanic rocks of Hulusimpang. Similar mineralization was also reported by Zwierzycki (in Kisman and Sutisna, 2012) who found the Cu-Pb-Zn sulfide in quartz veins of Bukit Dandar, west coast of Lampung Bay. Furthermore, Pb-Zn sulfide was also available within quartz veins of metamorphic schist at Gunung Kasih Complex of Bekarang river.

Kedondong gold ore is included in mining business permit areas of PT Karya Bukit Utama (Figure1). Geologically the area that belongs to South Lampung is dominated by volcanic rocks, namely consist of andesitic breccias, granite porphyry, lapilli tuff and andesitic tuff. Ore occurs as primary and secondary deposits within quartz veins of old andesite formation. The later belongs to a debris production of tuff breccias that are mostly deposited at the valley and surrounded river (Tahli, 1998). For processing purposes, some gold-bearing deposits were sampled at representative places. The samples were then tested to evaluate its character. Such characterization testing included fire assays, sieve analysis, mineral liberation degree and mineragraphy (Saleh and Tahli, 2004).

Gravity concentration method for separating the minerals employs the difference of mineral specific gravity. However, the method also requires another pre-requisite to yield successful process, namely concentration criteria or known as CC of the separated mineral should be >2.5 (Taggart, 1967). The technique is one of the oldest techniques for separating minerals and retains some advantages, namely low capital and operating costs as well as lack of chemicals and excessive heating requirements or in other words it is generally environment friendly (Falconer, 2003). Prior to processing raw material by gravity concentration, the feed needs to be prepared through a series of preparation such as crushing, grinding and sieving using jaw and roll crusher as well as sieve. When ready, the material goes to a series of gravity concentration equipments such as Knelson concentrator, shaking table and sluice box.

Study of gravity concentration for processing the gold had been conducted by Alp et al. (2008) by recovering the gold from a free-milling ore using a centrifugal gravity separator. The test results indicated that around 81% of the gold came from -74 mm-ground ores were recovered. The initial Au content (262 g/t) improved to 1,760 g/t and performed 33.80% recovery. Saleh and Tahli (2004) treated the underflow of mill cyclone from Pongkor mine as the feed for processing the gold ores by gravity concentration method. The size of the feed was -60+200 mesh and the initial Au and Ag grades were 18.78 and 83.76 g/t respectively. The equipment included jig and shaking table. The result showed that the Au grade improved from 18.78 to 87.73 g/t and the achieved recovery belonged to 74.45%. When the jig concentrate was processed by shaking table, it showed the increase of Au grade to 495 g/t with 96.43% of recovery. This means that such a method is promising for processing the gold ore.

METHODOLOGY

Samples used for this study were randomly derived from some trenches using grab sampling method. Prior to using them as the feed for gravity concentration, the samples were analyzed in the laboratory to evaluate their characteristics. Sample preparation included drying, breaking and grinding into the desired grain size. Some samples went to Chemistry and Mineralogy Laboratories to evaluate its chemical and mineralogy characters. Gold and silver grades were analyzed through fire assay method while mineragraphy, sieve, liberation degree, shape and grain size analyses belongs to the Mineralogy Laboratory.

When processing the feed applying gravity concentration method, there are two alternatives for setting the employed equipments. Figure 2 shows

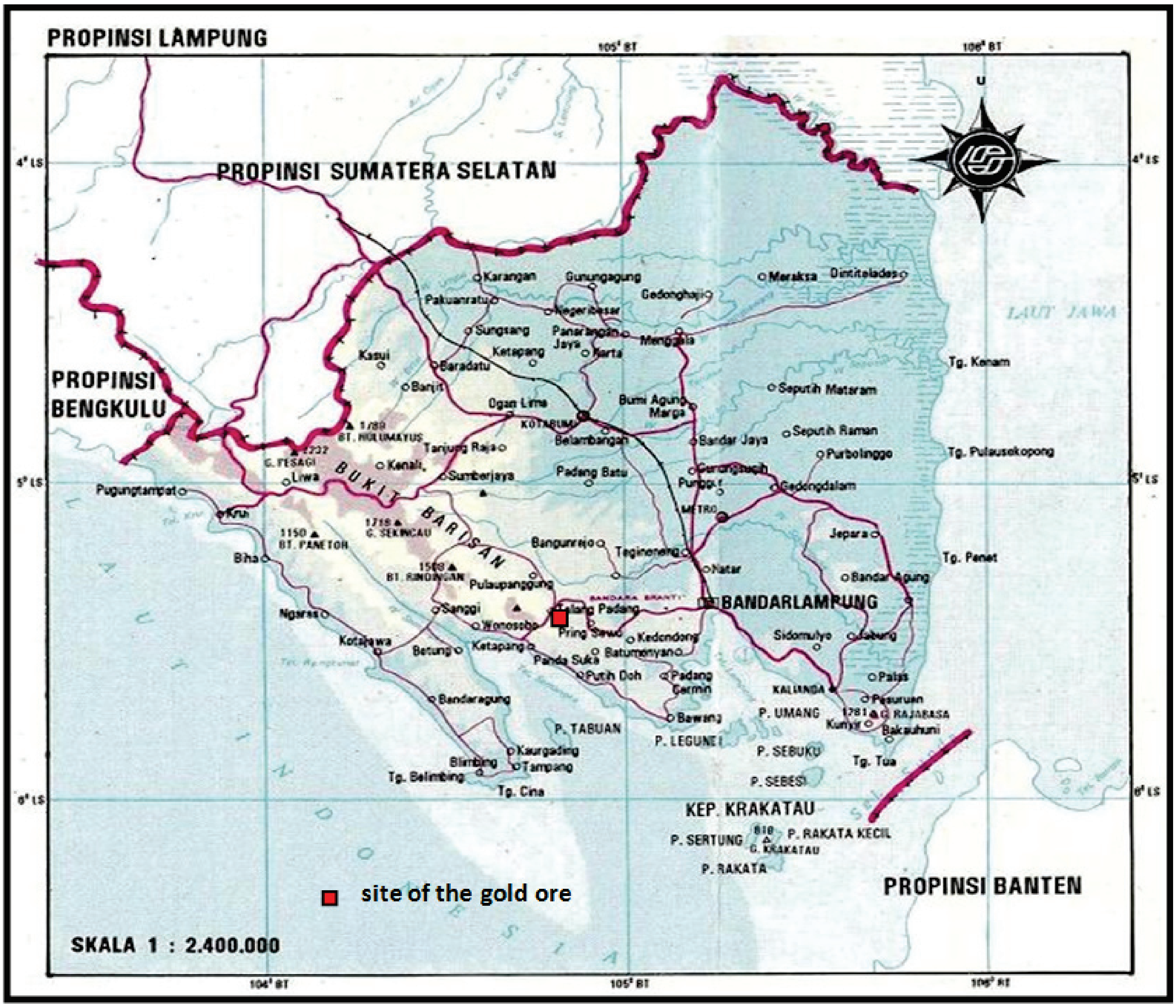

Figure 1. Kedondong of South Lampung (red mark) at which the gold ore is available

the first alternative of equipment setting (Anon., 2008). Started with preparation process using several equipments, the prepared feed goes to Knelson concentrator that serves as a rougher. Knelson concentrates are then upgraded through a cleaner process by shaking table for its gold content. Yet; in terms of preventing the possibility of losing gold particles, the tailings of shaking-table are treated through scavenger process by a sluice box. A flow chart representing the second alternative of processing the gold is illustrated in Figure 2. Jigging is the first procedure in this alternative, yielding concentrates and tailings. The former goes to a shaking table to get a better gold content while the later moves to a sluice box. Both concentrates and tailings are then analyzed their Au and Ag contents using fire assay method.

Referring to the flow chart, conditions to process the ores for each equipment are as follows:

- Knelson concentrator
  feed size = -100 mesh, feed rate = 2.2 kg/mt, water pressure = 2.5 kg/cm;
- jig
  bed thickness (hematite) = 3.0 cm, stroke length = 1.0", feed size = -100 mesh, feed rate = 3.2 kg/mt, % solid = 20%;
- shaking table
  feed rate = 300 g/mt, slope = 2.0o, water consumption = 14 l/mt, % solid = 15 %, stroke length = 0.75";
- sluice box
  slope = 3.0°, % solid = 25 %, feed rate = 2.2 kg/mt.

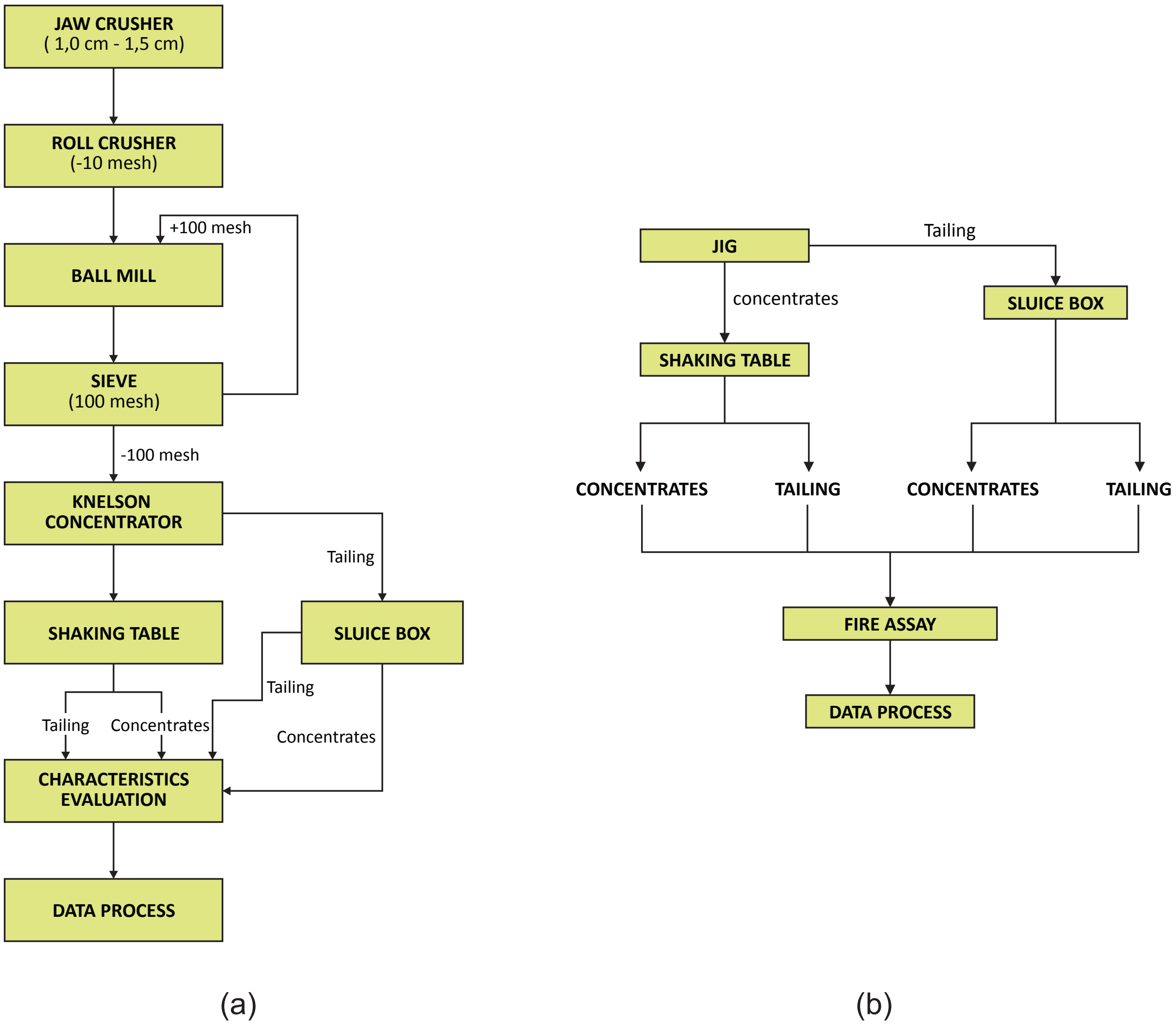

Figure 2. Two flow charts illustrate the two alternatives for processing the gold, using Knelson concentrator (a) and jig (b)

RESULTS AND DISCUSSION

Around 7 representative samples taken from the field were analyzed for their gold and silver contents using fire assay method (Table 1). Of the 7 samples, only two of them retain the gold content bigger than 8 g/t. Others are less than 5 g/t Au. Therefore, the study focuses to both samples, coded A and B. Among both samples, Sample A retains the highest content while the gold content within Sample B is less than 10 g/t. In terms of optimizing beneficiation of the ores, such both Sample A and B need to be processed to get higher gold content.

Not only should the gold content be known prior to processing the ores but also its mineralogical characters should be evaluated. Mineralogical evaluation on Sample A and B perform some characters as shown in Table 2. Of the various minerals available within samples, pyrite, chalco-

Table 1. Result of fire assay tests on gold sample from Kedondong, South Lampung

No.	Sample code	Au	Ag
		Content (g/t)	
1	A	21.87	287.83
2	B	8.93	172.73
3	C	4.09	29.83
4	D	2.09	33.68
5	E	5.50	74.77

Table 2. Result of mineralogy analyses for Sample A and B of Kedondong ore

Sample code	Identified mineral	Gold size (mm)	Gold shape
A	- pyrite, pale yellow , isotropic, high relief, fine cubistic, liberated - chalcopyrite, yellow, fine, liberated - limonite, clouded grey, pyrite alteration - gold, yellow gold, 0.20-0.30 mm, bounded wit quartz, pyrite and limonite or liberated	0,20-0,30	flat
B	- pyrite, pale yellow , isotropic, high relief, fine–very fine cubistic, liberated - chalcopyrite, yellow, fine, liberated - limonite, clouded grey, pyrite alteration - gold, yellow gold, 0.20-0.30 mm, bounded with quartz, pyrite and limonite	0,06-0,08	flat - rounded

pyrite, limonite and gold serve as the dominant metal minerals. Quartz is the dominant non- metal mineral. Encapsulation seems the most common structure in both samples. Gold is included by quartz, pyrite or limonite. Sometimes the particle shows double inclusion at which the gold is encapsulated by pyrite or limonite and both particles are included by quartz. Gold distributed along the boundary of two minerals is another structure that is available in these samples or it occurs as single particle. Figure 3 illustrates photomicrographs of sample A and B from Kedondong area.

Mineral dressing consists of liberation and separation. A reasonable degree of liberation is prerequisite to make a fair separation. Referring to such a statement, the later becomes impracticable if the former has not successfully been accomplished. As one of the most important steps in mineral dressing, liberating the minerals means that the dissimilar elements within feed materials are freed from one another or the valuable minerals are released from the associated gangue minerals at the coarsest possible size from its gangue association. Free particles of the ore refer to those that consist of single mineral while locked particles belong to those that contain two or more minerals. It can be binary, ternary etc depending upon the kinds of minerals they contain. Normally, objective of mineral liberation can be achieved by size reduction and detachment.

In terms of evaluating liberation degree of gold, fractionation had been accomplished to Sample A and B. The fraction size includes + 60, -60+100, -100 +150, -150 +200 and -200 #. To get desired sizes, the samples was ground for 30 minutes and then sieved into determined fraction. The results are illustrated in Table 3 and Figure 4. For Sample A, totally around 85.03% particles have been distributed into fraction -100 through -200#. The liberated gold achieves 70% and increases to 100% at -150#. Referring to such a condition, processing Sample A using gravity concentration method is technically and economically promising. If the gravity concentrates then goes to cyanidation process, it requires more grinding time to get more than 90% particle size that belongs to -200#. This means that the finer the particle the more liberated the gold. As the gold content of Sample A is bigger than 20 g/t, the samples can also be processed by amalgamation. However; such a process is not suggested due environmental restriction (Falconer, 2003).

Result of sieve analysis for Sample B is shown in Table 4 and Figure 5. The result exhibits that after 30-minute grinding; totally around 82.47% particles have been distributed into fraction -100 through-200#. The liberated gold at that size is around 80% and increases to 100% at -150#. Referring to such a fact, Sample B can also be processed by gravity concentration method. However, processing the gravity concentrates by cyanidation requires longer grinding times in order to get more particle with -200# (>90%). In this case, amalgamation is not suggested as the gold content is only 8.93%. Successful amalgamation requires the gold content ≥20 g/t.

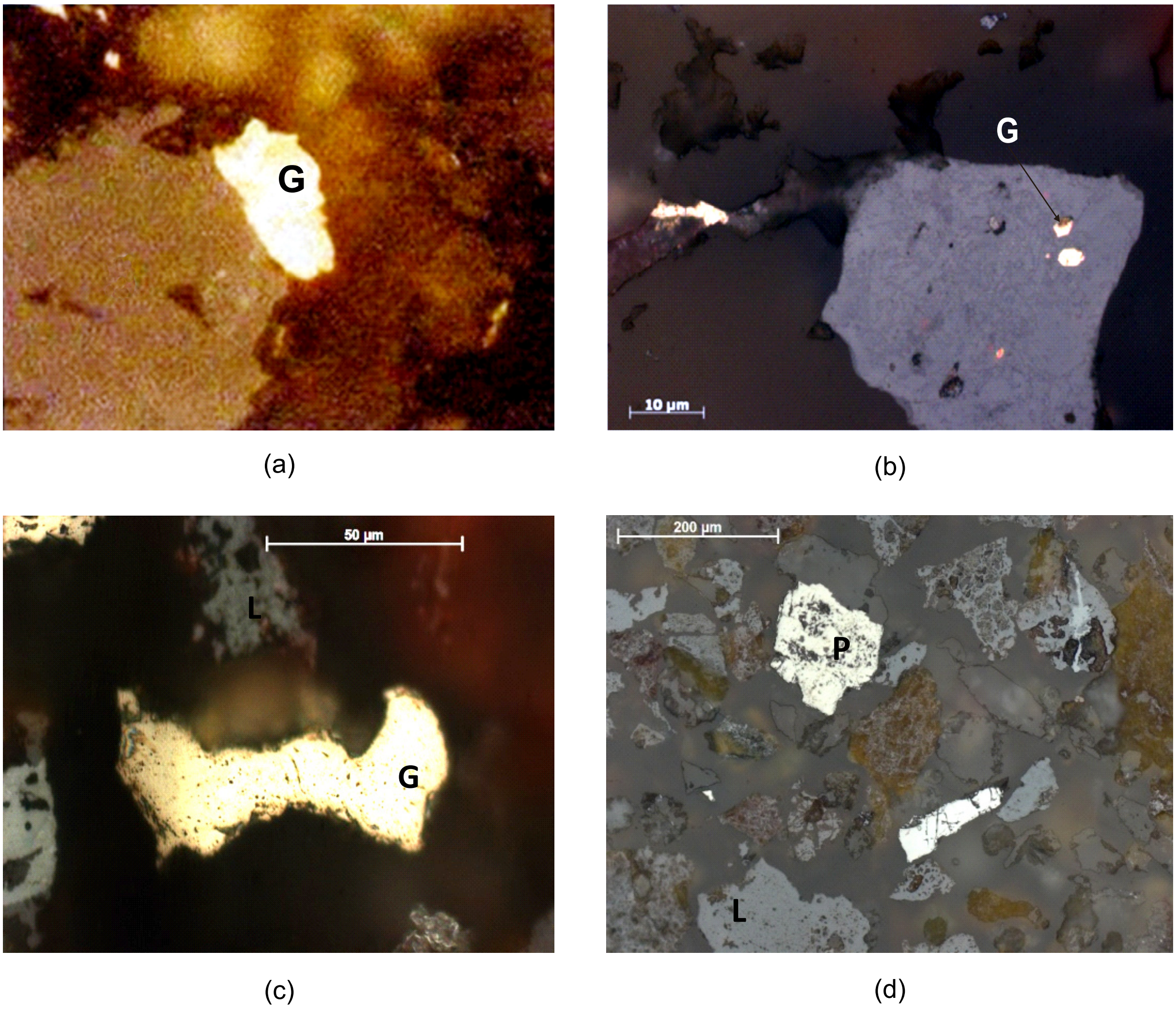

Figure 3. Gold is included by pyrite (a) and double inclusion structure of gold particle in pyrite and quartz (b). Single liberated gold particle among quartz found in sample A (c) and bright pyrite in sample B among grey limonite (d).

Table 3. Sieve analysis and liberation degree for Sample A, ground for 30 minutes.

Fraction (mesh)	Weight		Cumulative wt. (%)	Liberation degree (%)
	g	%		
60	22,28	2,60	2,60	na
-60 + 100#	106,06	12,37	14,97	na
-100 + 150#	78,35	9,15	24,12	70,00
-150 + 200#	75,99	8,86	32,98	100,00
-200#	574,43	67,02	100,00	100,00
Total	857,11			

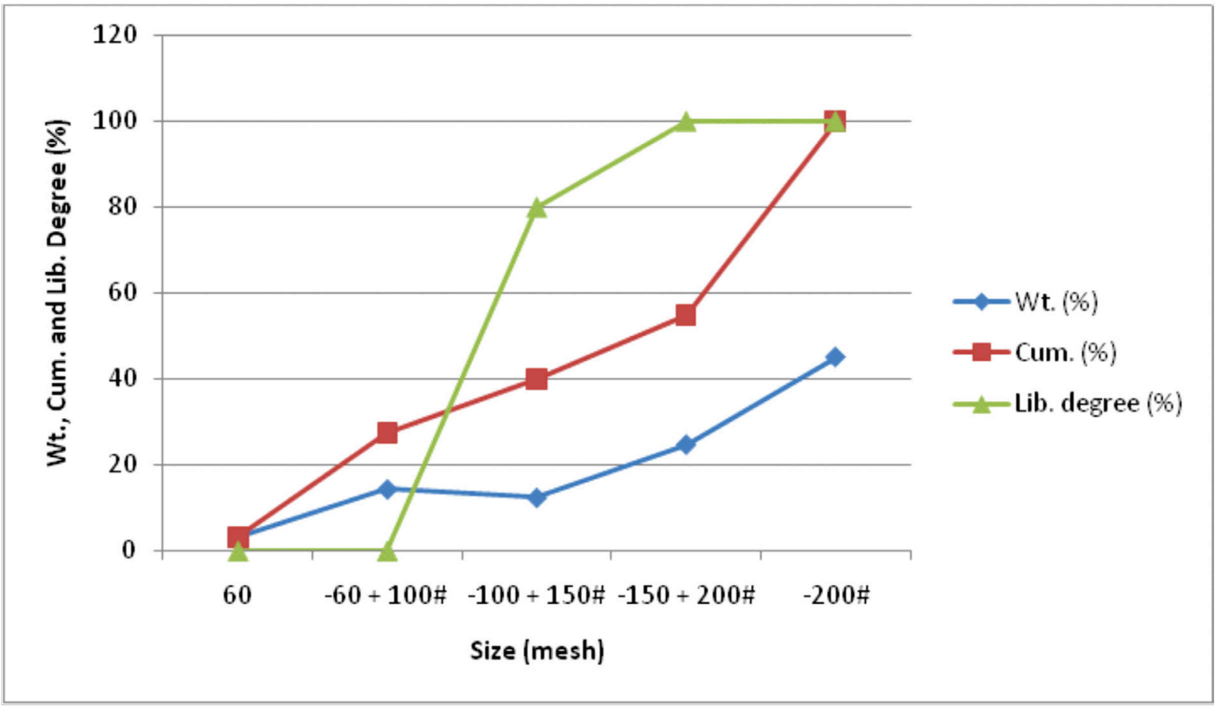

Figure 4. Fraction size versus %wt., cum. wt. and lib. deg. for Sample A, ground for 30 minutes.

Table 4. Sieve analysis and liberation degree for Sample B, ground for 30 minutes

Fraction (mesh)	Weight		Cumulative wt. (%)	Liberation degree (%)
	g	%		
60	19,62	3,16	3,16	na
-60 + 100#	151,41	14,37	27,53	na
-100 + 150#	77,22	12,43	39,96	80,00
-150 + 200#	92,16	24,83	54,79	100,00
-200#	280,88	45,21	100,00	100,00
Total	621,29			

In terms of evaluating in what fraction gold was available, the fractionated samples were then analyzed its mineralogical characters through optical microscope analyses. The fact that Sample A and B comprise similar mineralogy and Sample A own higher Au content than that of Sample B (Table 1 and 2, Figure 3) results in using Sample A for concentration-criteria (CC) and optical microscope studies. CC determines whether the gold can be separated or not. Separation is easy if the CC is bigger than 2.5 (Taggart, 1967). Fraction unit includes +60 through -200 mesh. Of the five size fraction units, gold is available only in -100 +150, -150 +200 and -200 # performing flat and rounded shape, however, they mostly resides in -100 +150 and -150 +200#. The result is shown in Table 5. Gold is mostly associated with -100+150 and -150+200#.

Prior to processing the samples by gravity concentration, it needs evaluating its concentration-criterion or known as CC using formula as follows:

$$CC = \frac{\rho_H - \rho_F}{\rho_L - \rho_F} \geq 2.5 \text{ (Taggart, 1967)}$$

ρH : specific gravity of the heavy mineral
ρL : specific gravity of the light mineral
ρF : specific gravity of the fluid

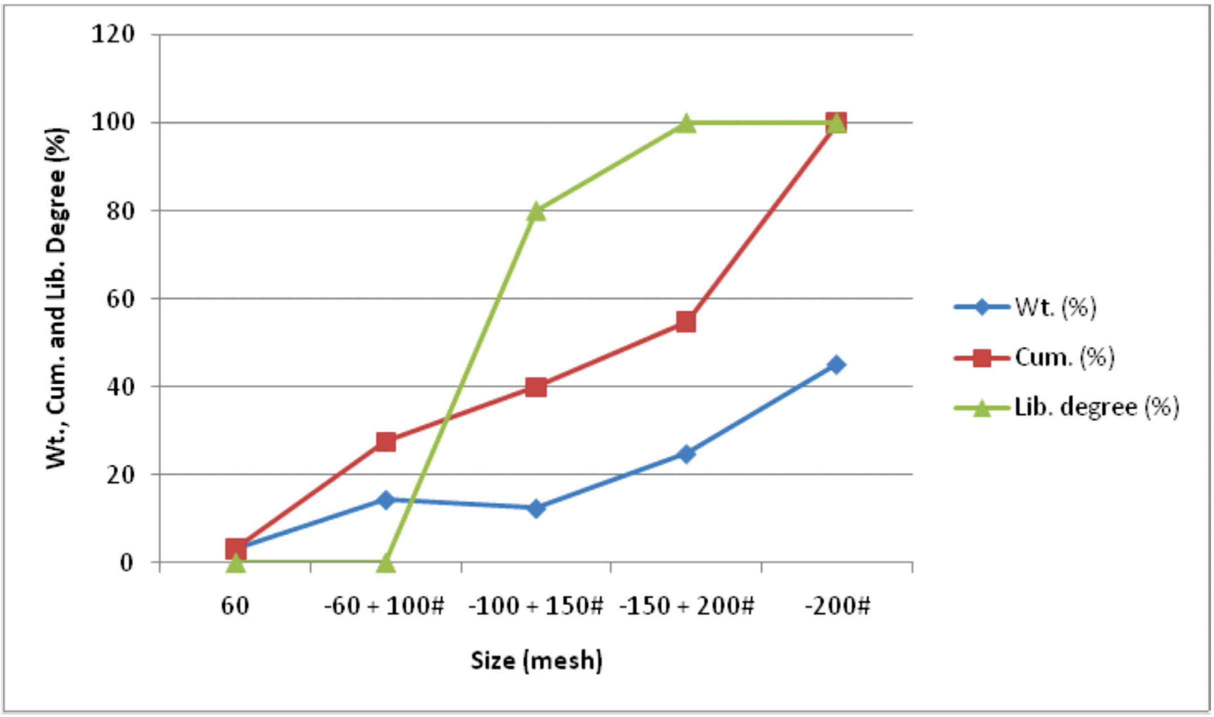

Figure 5. Fraction size versus %wt., cum. wt. and lib. deg. for Sample B, ground for 30 minutes.

Table 5. Result of mineralogy analyses for fractionated Sample A

Sample size	Mineral composition of fractioned Sample A(%)						Physical characters for gold of fractionated Sample A		
	Pyrite	Chalcopyrite	Limonite	Ilmenite/ Hematite	Gangue minerals	Gold	Size (mm)	Shape	Lib. deg. (%)
+60 #	9	3	66	8	14	na	-	-	-
-60 +100 #	10	3	70	5	12	na	-	-	-
-100 +150 #	10	4	65	6	15	8x10-3	0,02	flat	70
-150 +200 #	8	2	71	5	14	9x10-3	0,01	rounded	100
-200 #	7	na	72	5	16	3x10-3	0,015	flat-rounded	100

Table 6 illustrates the CC for Sample A. Based on the data in Table 6, all calculated CCs are bigger than 2.5. It means that both Sample A and B from Kedondong can be processed by gravity concentration method.

Table 7 and 8 show the result of gold processing for Sample A and B. The process employs a series equipment as stated in Figure 2a while Table 7 illustrates the processing result of Sample A using the flow chart as depicted in Figure 2b. Due to the initial Au content of Sample B is relatively diminutive, it does not process utilizing this chart. Based on such results, Sample A and B satisfy the conditions to be processed using gravity concentration method. Fire assays and mineralogy tests confirm this condition as shown in Table 1 and 2. Sample A and B are dominated by pyrite, chalcopyrite, limonite and gold. Quartz serves as gangue mineral. The gold in Sample A retains coarse size (0.20-0.30 mm) and flat shape while in Sample B, the gold is relative fine (0.06-0.08 mm) showing rounded to flat shape. The calculated concentration-criterion for Kedondong ores belongs to 4.23 through 10.91. Results in processing the ores using gravity concentration method is easy for each size. Moreover, the percentage of -100# fraction for both samples and 30-minute

Table 6. Concentration-Criterion (CC) for Sample A

No	Mineral-Mineral	CC
1	Gold-Pyrite	4.50
2	Gold-Chalcopyrite	5.45
3	Gold-Limonite	6.00
4	Gold-Ilmenite	4.74
5	Gold-Hematite	4.23
6	Gold- Quartz	10.91

Table 7. Processing Sample A by gravity concentration method showing the increase of Au and Ag content

a. Processing bulk sample by Knelson concentrator
Initial feed : 5 kg; Initial Au content : 21.87 g/t; Initial Ag content : 287.83 g/t

No.	Product	Weight (%)	Content (g/t)		Recovery (%)	
			Au	Ag	Au	Ag
1	Concentrate	5.61	399.76	3.427.12	91.57	49.65
2	Tailings	94.99	1.94	152.55	8.43	50.35
	Total	100			100	100

b. Processing Knelson concentrates by shaking table
Initial Au content : 399.76 g/t; Initial Ag content : 3,427 g/t

No.	Product	Weight (%)	Content (g/t)		Recovery (%)	
			Au	Ag	Au	Ag
1	Concentrate	1.68	1.199.28	5.430.80	89.84	47.45
2	Tailings	3.93	9.87	108.1	1.73	2.2
	Total	5.61			91.57	49.65

c. Processing Knelson tailings by sluice box
Initial Au content :1.94 g/t; Initial Ag content : 152.55 g/t

No.	Product	Weight (%)	Content (g/t)		Recovery (%)	
			Au	Ag	Au	Ag
1	Concentrate	1.74	8.85	4.054.00	8.36	48.68
2	Tailings	93.25	0.0013	2.6	0.07	1.67
	Total	94.99			8.43	50.35

grinding has achieved 80% with liberated gold particle >70%. However, the fact that some of the ore shapes are flat requires an extra handling compared to those with rounded one when dealt with gravity concentration method. Technically, after treating the ores by gravity concentration method, both samples can be processed by amalgamation and cyanidation followed by CIL adsorption.

When processed by gravity concentration method, a combination of Knelson concentrator, shaking table and sluice box significantly enhance the Au and Ag contents (>80%). For Sample A (Table 5), a rougher step by Knelson concentrator yields 5.61% concentrates and raises the Au content from 21.87 to 399.76 g/t Au. The yielded recovery is 91.57%. Not only does the Au content increase but also the Ag content improves from 287,83 to 3.427,12 g/t performing recovery of 49,65 %.

Processing concentrates comes from Knelson concentrator by shaking table produces the concentrates around 1.68%. The Au and Ag content improve from 399.76 to 1,199.28 g/t and 3,427.12 to 5,430.80 g/t respectively, performing Au and Ag recoveries of 89.84 and 47.45% respectively. Scavenging the gold and silver from Knelson tailings using sluice box also develop their content from 1.94 to 8.85 g/t and 152.55 to 4,054.80 g/t respectively. The produced concentrate is 1.74% presenting Au and Ag recoveries around 8.36 and 48.68% respectively. The produced sluice box tailings from Sample A is 93.25%, however, its Au and Ag contents are very low, around 0.0013

Table 8. Processing Sample B by gravity concentration method showing the increase of Au and Ag content. Compared to Sample A, the increase is not significant as that of Sample A

a. Processing bulk sample by Knelson concentrator
Initial feed : 5 kg; Initial Au content : 8.93 g/t; Initial Ag content : 172.73 g/t

No.	Product	Weight (%)	Content (g/t)		Recovery (%)	
			Au	Ag	Au	Ag
1	Concentrate	4.7	165.8	3.275.05	87.26	89.11
2	Tailings	95.3	1.194	19.74	12.74	10.89
	Total	100			100	100

b. Processing Knelson concentrates by shaking table
Initial Au content : 165.80 g/t; Initial Ag content : 3,275.05g/t

No.	Product	Weight (%)	Content (g/t)		Recovery (%)	
			Au	Ag	Au	Ag
1	Concentrate	0.95	710.05	13,800.80	86.56	85.17
2	Tailings	3.75	1.45	161.71	0.7	3.94
	Total	4.7			87.26	89.11

c. Processing Knelson tailings by sluice box
Initial Au content :1.194 g/t; Initial Ag content : 19.74 g/t

No.	Product	Weight (%)	Content (g/t)		Recovery (%)	
			Au	Ag	Au	Ag
1	Concentrate	1.85	6.52	95.2	10.6	9.36
2	Tailings	93.45	0.026	0.31	2.14	1.53
	Total	95.3			12.74	10.89

and 2.60 g/t respectively. Referring to such a condition, sluice box tailings are not economized to be re-processed.

Improvement also occurs when Knelson concentrator processes Sample B that retains 8.93 g/t Au, Table 6). The Au content enhances to 165.80 g/t performing recovery of 87.26%. Silver content within this sample also upgrades from 172.73 to 3,275.05 g/t with recovery of 89.11%. Compared to silver, the increase of gold content is insignificant when the concentrate of Knelson concentrator is re-processed using shaking table. The final Au content is 710.05 g/t performing recovery of 85.56% while the Ag content significantly improves to 13,500.80 g/t with recovery of 85.17%. Re-processing Knelson concentrator tailing by sluice box improve both Au and Ag contents to 6.52 and 95.20 g/t respectively whilst their recoveries belong to 10.60 for gold and 9.36% for silver. The fact that 93.45% sluice box tailing retain only 0.026 g/t Au and 0.31 g/t Ag suggests that the tailing is not proper to be re-processed both technically and economically.

Processing concentrates comes from Knelson concentrator by shaking table produces the concentrates around 1.68%. The Au and Ag content improve from 399.76 to 1,199.28 g/t and 3,427.12 to 5,430.80 g/t respectively, performing Au and Ag recoveries of 89.84 and 47.45% respectively. Scavenging the gold and silver from Knelson tailings using sluice box also develop their content from 1.94 to 8.85 g/t and 152.55 to 4,054.80 g/t respectively. The produced concentrate is 1.74% presenting Au and Ag recoveries around 8.36 and 48.68% respectively. The produced sluice box tailings from Sample A is 93.25%, however, its Au and Ag contents are very low, around 0.0013 and 2.60 g/t respectively. Referring to such a condition, sluice box tailings are not economized to be re-processed.

Table 9 illustrates the result of gold processing that refers to the flow chart as stated in Figure 2b. The achieved concentrates come from rougher process using jig is 3.90% performing high achievement of gold content (481.03 g/t). The recovered Au is 85.78%. The rougher step also yields recovered silver (60.41%) that retains content around 4,458.80 g/t. A cleaner step by shaking table, applied to jig concentrates, result in enhancing the Au content to 1,365.60 g/t with the recovered Au 84.44% and the Ag content to 8,850.10 g/t with its recovery around 59.04%. Scavenging process of jig tailing by sluice box is capable to increasing both gold and silver. Of 2.41% achieved concentrates, gold and silver contents improve to 16.70 and 270.50 g/t respectively performing recovery of 12.95% for Au and 36.49% for Ag. The low grade of Au and Ag within sluice box tailings shows that such a tailing is not suitable to be re-processed.

Though processing the gold from Sample A using jig is promising, in order to get maximum results, it needs seeking a better processing variable. The calculated material balance for sample A as shown in Figure 6 suggests that product distribution for its flow is relatively good. This means that processing Sample A can be developed into pilot plant scale. Concerning Sample B; though its processing results shows the increase of Au content and recovery, its increase is lower than that of Sample A. One more step is required if Sample B will be treated to pilot plant scale. The step is a cleaner one by shaking table.

Generally, processing Sample A and B by gravity concentration method performs a good result. However, a modification of processing flow chart is required to get a better result by revising Figure 2a-flow chart. The old flow chart is modified by replacing the roll crusher for stage 2-crushing with the cone crusher as well as inserting classification and smelting processes. The former is conducted in a hydrocyclone and the later in a crucible or induction furnaces as shown in a new, suggested flow chart (Figure 7).

CONCLUSION

Gold content affects significantly to the success of gold ore processing using gravity concentration method. Of the two sample types with different Au content, Sample A, performing Au content bigger than that of Sample B (21.87 g/t), increases its Au content to 399.76 g/t when processed at a

Table 9. Processing Sample A by jig, shaking table and sluice box. Though the increase of concentrate weigh after process is insignificant, the Au and Ag content slightly increases.

a. Processing bulk sample by jig
Initial feed : 5 kg; Initial Au content : 21.87 g/t; Initial Ag content : 287.83 g/t

No.	Product	Weight (%)	Content (g/t)		Recovery (%)	
			Au	Ag	Au	Ag
1	Concentrate	3,90	481,03	4.458,80	85,78	60,41
2	Tailings	96,10	3,235	118,59	14,22	39,59
	Total	100,00			100,00	100,00

b. Processing jig concentrates by shaking table
Initial Au content : 481.03 g/t; Initial Ag content : 4,458.80 g/t

No.	Product	Weight (%)	Content (g/t)		Recovery (%)	
			Au	Ag	Au	Ag
1	Concentrate	1,16	1.365,60	8.850,10	84,44	59,04
2	Tailings	2,74	9,20	87.02	1,34	1.37
	Total	3,90			85,78	60,41

c. Processing jig tailing by sluice box
Initial Au content : 3.235 g/t; Initial Ag content : 118.59 g/t

No.	Product	Weight (%)	Content (g/t)		Recovery (%)	
			Au	Ag	Au	Ag
1	Concentrate	2,41	16,70	270,50	12,95	36,49
2	Tailings	93,69	0,042	0,59	1,27	3,10
	Total	96,10			14,22	39,59

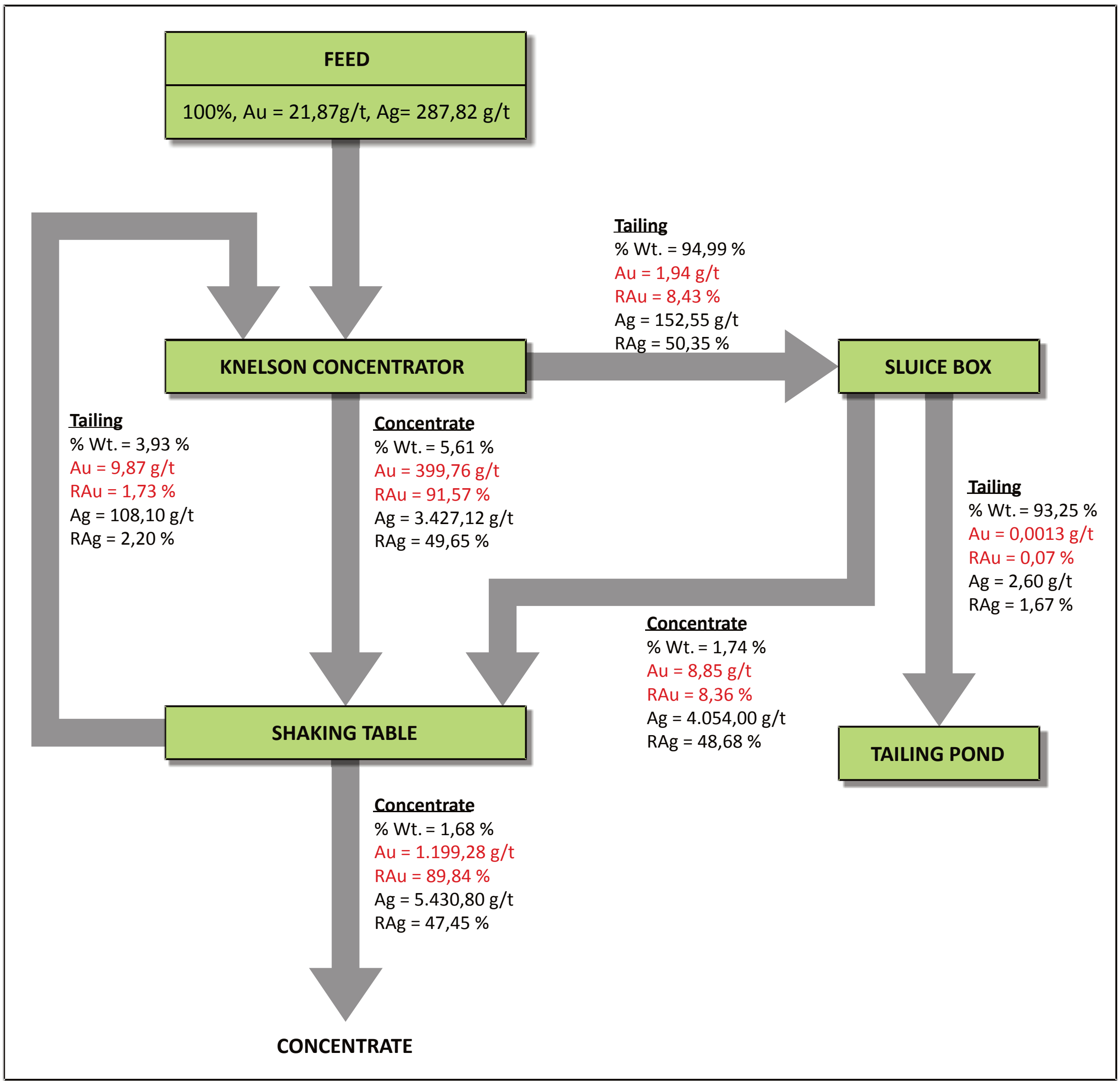

Figure 6. Calculated material balance for Sample A when processed by Knelson concentrator, shaking table and sluice box.

rougher step by Knelson concentrator. Its recovery is 91.57%. Re-cleaning Knelson concentrates by shaking table enhances the Au content to 1,199.28 g/t performing recovery of 89.84%. Though processing Sample B by gravity method shows a good performance, its Au content and recovery are not as significant as that of Sample B. Compared to Sample A, the increase of Au content in sample B is only 165.80 g /t while the achieved recovery is 85.56%. The fact that concentrate from Sample A achieves the Au content >1,000 g/t implies that such a sample satisfies the requirement to go for smelting stage while Sample B entails one more step in order to get the Au content >1,000 g/t, namely re-processing it with shaking table.

Processing Sample A using a series equipment as shown in Figure 2b yields a gold content that is bigger than those processed by the flow chart as stated in Figure 2a. A rougher process by jig yield the Au content around 481.03 g/t and recovery of 85.78%. Cleaning jig concentrates by shaking table improve the Au content to 1,365.60 g/t with recovery of 84.44%. Though processing the ores using flow chart as stated in Figure 2a is promising, lesser capacity and continuity of the process is a contraint.

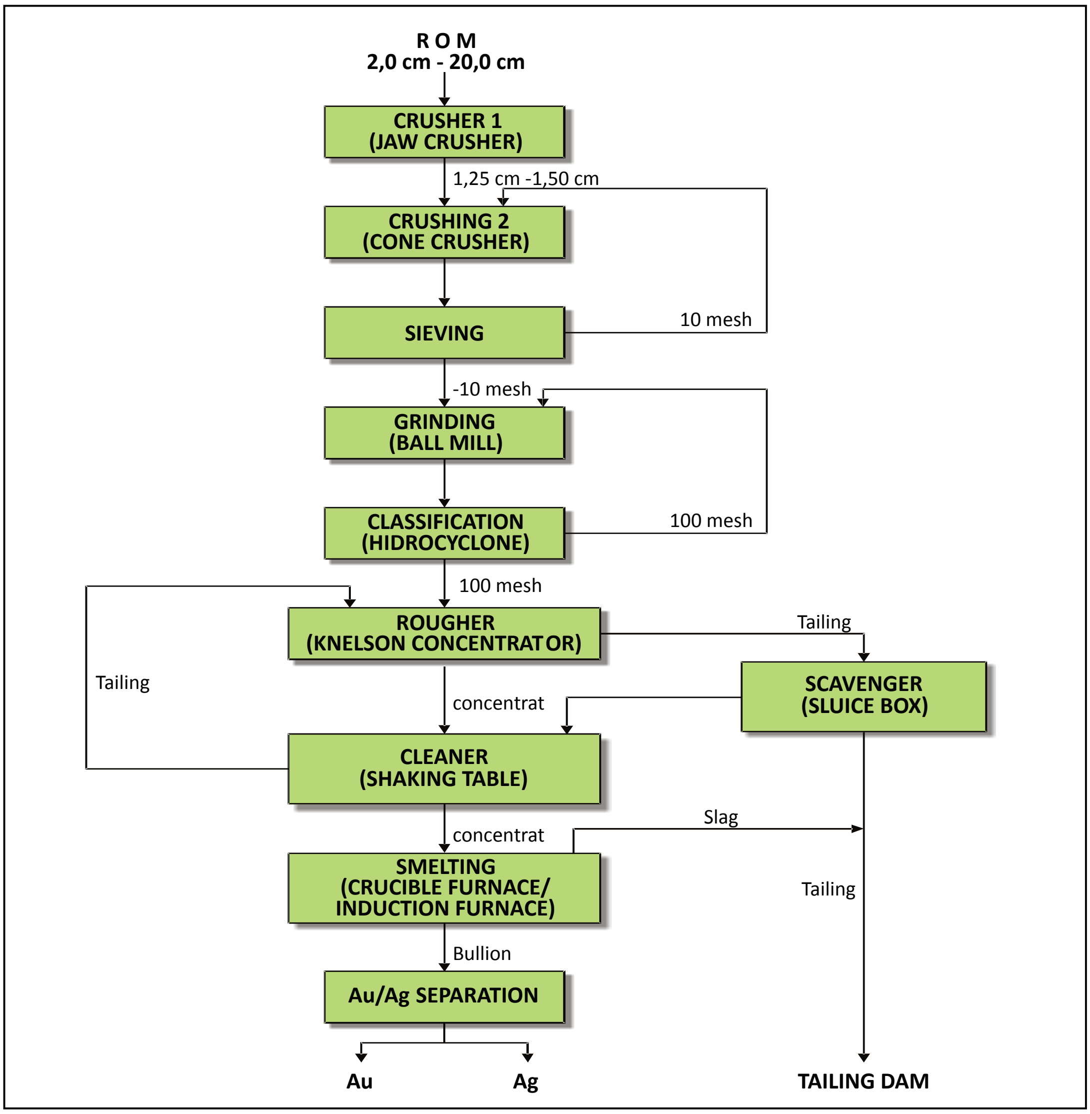

Figure 7. Suggested flow chart for a better gold recovery, modified from Figure 2a-flow chart.

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