The research of gold processing from tailings of iron sand processing from South Kalimantan by using amalgamation methods in West Java

L Pulungan*, P Pramusanto and F A Hermana
Mining Engineering, Faculty of Technic, Universitas Islam Bandung

*linda.lindahas@unisba.ac.id

Abstract. The purpose of this activity was to determine the characteristics of gold contained in iron sand mining tailings based on mineragraphic parameters, gold recovery by amalgamation method, and Hg used and wasted with tailings in the amalgamation process. The results showed the characteristics of gold based on mineragraphic parameters had a bright yellow gold colour, irregular shape, isotropic crystals, low relief, not yet liberated, measuring between 0.04 - 0.25 mm, mostly tied to minerals contains Fe and some binds to non-metallic minerals. The recovery of a pure sample is 90.83%, with the use of mercury 5.6 grams, and the mercury lost with its tailings as much as 6.4 grams. As for the samples that have been recovered, the recovery was 25.5% with the use of 1.4 grams of mercury, and 6.6 grams of mercury lost with tailings.

1. Introduction
The amalgamation process to separate gold from loose ore using mercury or mercury is still done by traditional gold miners, although the use of mercury has been banned. Exposure of mercury to the environment can cause various health problems. According to research conducted by Peter W. U. Appel, small-scale mining in Indonesia requires 20 to 50 grams of mercury to extract 1 gram of gold [1].

From several studies on gold processing using amalgamation carried out by direct method, where gold ore, milled media, quicklime, water, and mercury together into amalgamators. Obtaining low concentrated gold (<60%). In the research, the location was located in South Kalimantan Province, there was iron ore mining which contained gold tailings. This is not a common thing, but this is in accordance with the description of sedimentation in the previous paragraph. With the presence of gold ore in the iron sand mining tailings, eventually, the surrounding communities made gold processing their livelihood. The gold processing method carried out by the surrounding community is an amalgamation with traditional mechanical devices (drum machines), and also with manual tools (panning). Feeders used as gold ore binding media are mercury (Hg). Therefore, in this study the authors wanted to examine the recovery of gold found in iron sand mining tailings, using the amalgamation method mechanically and manually.

Based on the background described, the formulation of the problem in this study is as follows: "Is the characteristic of gold as in the location of the sample effective if it is treated with the amalgamation method using hazardous substances (mercury)". Furthermore, the objectives in this study are described in the following points.
To find out the characteristics of gold found in iron sand mining tailings.
To find out the acquisition of gold by amalgamation method.
To find out which Hg is used and Hg that is wasted with tailings in processing with the amalgamation method.

2. Methods

2.1. Gold in samples
Indonesia has several ophiolite complexes such as those found in the Bobaris Mountains and the Meratus Mountains in South Kalimantan. In the area of the ophiolite complex, many mineralizations were found that appeared locally and limited gold was found. This is probably related to gold mineralization associated with the ophiolite complex. Gold mineralization occurs in ultramafic environments.

The Meratus Mountains in South Kalimantan have long been known to contain iron ore, which is then transported by rivers that flow from the Meratus mountains to settle in areas around the foot of Mount Meratus. Of course, in the process of sedimentation, there are many other minerals that are carried along with iron ore, which includes minerals containing gold.

This study uses samples from iron sand mining tailings. Iron sand discerning uses 3 drums so that there is separation based on grain size. The tailings from the processing have flowed to the settling pond, then sucked and flowed to the magnetic separator to reduce the iron content in the tailings. Then the tailings are poured into the carpet to increase the concentration of gold. In principle, light minerals that are flowed through the carpet will be carried by water without being trapped in the carpet, while heavy minerals will be trapped when passing through the carpet. This is done because gold is a heavy mineral whose concentration will be increased.

2.2. Processing of amalgamation
Extraction is a separation process based on the distribution of solutes with a certain ratio between two solvents that do not mix with each other. There are two choice methods that can be applied in gold extraction namely cyanidation and amalgamation. In extracting metals from the ore, not all stages of the process must be carried out. If an ore can be processed technically directly with a hydrometallurgical process, then the next factor that influences the process selection is an economic factor.

Amalgamation is a gold metal extraction method that is more suitable for ore in the form of pure gold free or free gold with high gold content and has a coarse particle size or greater than 74 microns. The amalgamation process is carried out by mixing gold ore with mercury to form an Hg-Au alloy. Basically, amalgamation is a sika chemical process. Mercury envelops gold particles forming a paste called amalgam. The process follows the following mechanism:

\[ \text{Au} + \text{Hg} = \text{AuGg} \]

2.3. Laboratory analysis
The minerography analysis is an analysis of an impermeable mineral or often referred to as opaque minerals by making a polished section using a reflected microscope or often called the Reflected-Light Microscope.

XRF (X-ray fluorescence spectrometry) is a non-destructive analysis technique used to identify and determine the concentration of elements present in solids, powders or liquid samples. XRF is able to measure elements from beryllium (Be) to Uranium at trace element levels, even below the ppm level. In general, XRF spectrometers measure the wavelengths of individual material components from the fluorescent emissions produced by samples when irradiated with X-rays.

There are many ways to test gold, one of them is the Fire Assay method. The method has been around for hundreds of years where gold was discovered. It is not very clear since when this method was found, but what is certain is that this method is still believed to be the cheapest and most accurate method of testing gold levels, even the ability of this method can match the testing of gold levels using X-ray machines. The accuracy of this method can reach 0.04% and is ideal for objects with gold content.
between 33% - 92%. The Fire Assay method places more emphasis on metal properties under certain conditions of temperature and chemical properties.

3. Results and discussion

3.1. Characteristics of gold in samples
The mineragraphy analysis gives results in the form of photos called photomicrographs. From the results of the photomicrograph of the four samples shown in Table 1, it appears that there is an attachment of gold (Au) to other elements, meaning gold (Au) is not a loose grain. In the sample fraction -70 µ + 100 µ gold (Au) bound to magnetite (Fe₃O₄), in the sample fraction -100 µ + 150 µ gold (Au) is bound to the element limonite (FeO(OH)), in the sample fraction -150 µ + 200 µ gold (Au) is bound to hematite (Fe₂O₃), and in the fraction sample -200 µ gold (Au) is bound to non-metallic minerals. In this case, it means gold (Au) has properties that can be bound with metal and non-metallic minerals, and not certain with one mineral. There is not much research that can explain the gold content in iron ore tailings, research that has been done shows that iron ore does not contain gold [2], the presence of gold minerals in iron ore can be explained from the area of the ofiolite complex found in the location of iron ore found mineralization which appeared locally and limited to gold. This is probably related to gold mineralization associated with the ofiolite complex. Gold mineralization occurs in ultrabasa environments. The iron ore is transported by rivers that flow from the Meratus mountains to sedimented in areas around the foot of Mount Meratus. Of course, in the sedimentation process many other minerals are carried along with iron ore including minerals containing gold [3].

Table 1. Characteristics of gold-based on the mineragraphy test.

| Particle Size | Gold Characteristic | Similarities in the Characteristics of Gold at Every Particle Size |
|---------------|---------------------|------------------------------------------------------------------|
| 210 - 150 µ   | Measure 0,07 mm;    | Has a bright yellow gold color; Low Relief;                       |
|               | Lock with magnets.  | Isotropic;                                                        |
| 149 - 106 µ   | Measure 0,25 mm     | Irregular; and irregular shape (0% degree of liberation)          |
|               | Lock with limonite. |                                                                  |
| 105 µ – 75 µ  | Measure 0,15 mm     |                                                                  |
|               | Lock with hematite. |                                                                  |
| <75 µ         | Measure 0,04 mm;    |                                                                  |
|               | Lock with mineral non-metal |                                                          |
3.2. Characteristics of gold in samples
The characteristics of gold ore samples carried out by amalgamation with both tray and non-tray can be seen in table 2. Table 2 as follows from this calculation.

- Recovery Processing Amalgamation using with tray Samples
  Early sample grade = 122 ppm
  Early sample weight = 18 Kg
  Bullion grade (Au + Ag) = 0.7 gr / 18 Kg
  Bullion grade (Au) = 0.56 gr / 18 Kg
  Recovery of Amalgamation with tray samples 25.5%

- Recovery Processing Amalgamation with non -tray samples
  Early sample grade non-tray = 137 ppm
  Early sample weight non-tray = 18 Kg
  Bullion grade (Au + Ag) = 2.8 gr / 18 Kg
  Bullion grade (Au) = 2.24 gr / 18 Kg
  Recovery of Amalgamation non-Tray samples 90.835%

| Number | Grade (ppm or gr/ton) | Bullion (g) | Recovery Tray | Recovery Amalgamation |
|--------|------------------------|-------------|---------------|-----------------------|
| Sample | Early | End |              |                        |                        |
| Non-tray | 137 | 3.46 | 2.8 | - | 90.83% |
| Tray | 122 | 3.74 | 0.7 | 14.77% | 25.5% |

4. Conclusion
From the results of observations and experiments discussed in the previous chapters, the first finding is based on the mineragraphy analysis, gold contained in the tailings of iron sand processing has bright yellow gold, low relief morphological forms, isotropic crystalline shapes, irregular grain shape, grain size 0.04 mm - 0.25 mm, not yet irrigated, and binds to other minerals (magnetite, hematite, limonite, and also non-metallic minerals). The second finding is the recovery from traditional processing of samples with mechanical Amalgamation (gulundung) method in non-bone samples is 90.83%, while for samples that have been conducted panning is equal to 25.5%. The gold content in bullion is based on a water scale that is 80% or 19 carats. The level of gold is influenced by the contact area between mercury and gold grains. The last finding is mercury used in amalgamation experiments is as much as 200 grams. The remaining mercury in the sample is 192 grams, and the remaining non-bone sample is 188 grams. Mercury in amalgam samples is 1.4 grams, and in amalgam, non-bone samples are 5.6 grams. Mercury in tailings amalgamation of samples is 6.6 grams, and in the tailings amalgamation of non-doped samples is 6.4 grams.

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References
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