Identification of characteristics of the Kutawaringin Gold Ore Vein, Bandung, Indonesia, based on its alteration level in the bond work index test

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Abstract. The infiltration of hydrothermal solutions through structures that form veinlets with different alteration levels and variations in physical strength, will influence the consumption of grinding energy during processing operations. This research uses a gold ore vein sample from the Kutawaringin area, Bandung Regency. The sample, analyzed in the field by microscopic analysis, was tested in petrography and mineragraphy in the laboratory, so that it was found to be moderate and low altered. By taking into account the mineral composition, especially the percent of quartz minerals which when tested for Bond Work Index samples of PO and FR codes require greater energy consumption than those of the GL and KA code samples. This condition has an impact on the selection of the type of grinding equipment, if the alteration of gold ore vein is far more than the low alteration, more feasible choices based on the most vein, so it is more energy efficient. Although it results in decreased grinded production per unit time for low alteration types.

1. Introduction
Excellent tectonic conditions and the geological system of the Indonesian archipelago are very interesting to study, this is because in addition to being surrounded by a ring of fire, it is also located on the Eurasian plate extension in the southeast which is bounded to the south and west by the Indo-Australian plate (Indian Ocean) and from the east bounded by the Philippine sea and the Pacific plate [1]. This fact makes Indonesia rich in mineral resources making it one of the largest producers of metal minerals in gold, copper, nickel and tin. Specifically, the potential of gold metal ore is found in several areas, including West Java (Pongkor/Bogor, Jampang/Sukabumi, Ciseut/Purwakarta, Pangalengan/ Soreang Regency of Bandung, Cikondang/Cianjur, Cikotok/Cibaliung/Pandeglang/ Banten, Rejang Lebong (Bengkulu), Batu Hijau (Sumbawa-NTB) and others, which are part of the western segment of the Sunda-Banda Neogen Arc, which extends from Sumatra in the north across the southern part of Java and continues to the Maluku in the side east [2]. The formation of gold ore in some of the areas mentioned above, is very closely related to the rise of the remaining solution of magma to the surface of the earth through zones of structure such as faults, fractures and lithological contacts, known as hydrothermal solutions [3]. Hydrothermal solution is then mixed with meteoric water so that it undergoes a cooling process that forms veins (veinlets) with their shape depending on the cavity produced by the structure. During this process, the rock that is broken has undergone alterations followed by changes in physical properties and chemical composition. These changes include: changes in color, porosity, crystallinity, texture, hardness, etc. [4,5]. In the event of breakthrough of this
hydrothermal solution, in addition to altering the rocks that are broken through it also forms ore veinlets with physical properties and varying degrees of alteration or oxidation such as strong teralterasi vein, moderate or medium teralterasi vein and unaltered or fresh vein [5].

As explained above with the diversity of physical strength of ore veinlets, it will affect the reduction in ore size during the processing [6]. This happens considering that in the ore reduction or comminution operations in the process, there is a reduction mechanism involving forces such as the impact force, compression force, abrasion/attrition force and shear force, which will directly affect the energy consumption of the grinding which can be determined by the Bond Work Index test [6,7].

With the background as described above, the title of this study is "Identification of Characteristics of the Kutawaringin Gold Ore Vein, Bandung Regency, West Java Based on its Alteration Level in the Bond Work Index Test".

2. Methods
The research methodology carried out is divided into two stages, namely the first stage is the compilation and analysis of secondary data consisting of literature studies such as reading reference books, journals, papers on seminar results or previous research results, especially those related to the topic of this research. Next is the collection of primary data, which is obtained by conducting research directly in the field and in the laboratory. In the field, which is by direct observation of the outcrops and samples obtained, while in the laboratory of gold ore vein samples, petrographic, mineragraphic, degree of liberation and others are tested. This is needed to add and complete existing data so that it can support problem solving when discussing and drawing conclusions.

3. Results and discussion

3.1. Sampling of Gold Ore Vein
As a first step in conducting research, data collection and information regarding the conditions and types of gold ore vein that will be used in this study, the initial data and information is obtained by collecting previous research reports as secondary data and as primary data is analyzing / testing samples both in the field as well as in research objects or in the laboratory.

With various considerations and in accordance with the geological conditions of the mineralized area, obtained four gold ore samples with the code FR, KA, PO and GL. Following in figures (1, 2, 3 and 4) below we can see the condition and the income of gold ore vein obtained from the opening holes of the people's gold mining in Kutawaringin Village.

3.2. Laboratory test results of Gold Ore Vein samples
To the four gold ore vein samples above, in addition to the megasopic analysis conducted in the field, mineragraphy, petrographic analysis and sieving analysis were carried out at the Mineral and Coal Technology Research and Development Laboratory (Puslitbang Tekmira) and the Exploration Laboratory of Mining Engineering Study Program, Engineering Faculty, Bandung Islamic University. The following below can be seen photomicrographs of thin section samples of gold ore coded FR, KA, PO & GL from the results of petrographic analysis (figure 5) as well as in Figures 6 and 7 photo micrographic results of polished section results of mineragraphic tests.
Figure 1. Location Conditions Sampling FR Coordinates 6° 59.58’28"S and 107°30.2’04"E with an elevation of 870 meters above sea level which (MASL) has a position of N270°E/15° with a thickness of 3.2 cm.

Figure 2. Location Conditions Sampling KA Coordinates 6° 59.58’28"S and 107°30.2’04"E with an elevation of 870 MASL which has the position of N122°E/51° with a thickness of 4.7 cm.

Figure 3. Location Conditions PO Sampling coordinates 6° 59.56’17"S and 107°30’30"E with an elevation of 833 MASL which has the position of N109°E/24° with a thickness of 0.7 cm.

Figure 4. Location Conditions Sampling GL coordinates 6° 59.54’55"S and 107°29.53’81"E with an elevation of 844 MASL which has a position of N270°E/70° with a thickness of 1.3 cm.

Figure 5. Thin section photomicrograph of Gold Ore sample code FR, KA, PO, GL petrographic test results.
From the description both in the field or in the laboratory as explained above, in summary the results of petrographic and mineragraphic analysis of vein gold found ore in Kutawaringin District, Bandung Regency can be seen in the following table 1 below.

**Table 1.** Petrographic and mineragraphic analysis results of Kutawaringin Gold Ore Vein Bandung Regency (FR, KA, PO and GL sample codes) [6,9].

| Main Mineral   | Mineral Analysis Results | Ore Mineral | Ore Liberation | Remarks                  |
|----------------|--------------------------|-------------|----------------|--------------------------|
| **Petrographic Analysis** |                        |             |                |                          |
| **FR code gold ore sample** | Quartz 70%, Plagioclase albit 5% | Clay minerals (5% kaolinite) | Pirirrt FeS2, Chalcopyrite CuFeS2, Sphalerite PbS, fine grained gold mineral inclusions in pyrite minerals, have anhedral texture, non-fermented minerals. | FeS2 = 96.38% & PbS = 91.49% | Diorite acid igneous rocks, low / weak alteration |
| **KA code gold ore sample** | Quartz 20%, Plagioclase 10% | Clay minerals (55% kaolinite) | FeS2, CuFeS2, ZnS, PbS, have euhedral texture, fully mineralized minerals. | FeS2 = 90.04% & PbS = 91.04% | Diorite acid igneous rocks, medium alteration |
| **PO code gold ore sample** | 50% quartz, Plagioclase 2% | Clay minerals (kaolinite 5%, Chlorite 5%) | FeS2, CuFeS2, ZnS, PbS, Hematite Fe2O3, fine grained gold mineral inclusions in pyrite minerals, have anhedral texture, non-fermented minerals. | FeS2 = 87.55% & PbS = 89.43% | Diorite acid igneous rocks, low / weak alteration |
| **GL code gold ore sample** | Quartz 20% | Clay minerals (60% kaolinite) | FeS2, CuFeS2, ZnS, PbS, Fe2O3, Pirolusite MnO2, have euhedral texture, non-fermented minerals. | FeS2 = 92.69% & PbS = 88.24% | Diorite acid igneous rocks, medium alteration |
4. Conclusion

From field observations and petrographic laboratory analysis and mineragraphy of gold ore veins from Kutawaringin Bandung regency, can be categorized into two namely PO and FR code samples as low alteration type gold ore vein, while GL and KA code samples are medium alteration type gold ore veins. With regard to that also when considering the mineral composition, especially the percent of quartz minerals, if the Bond Work Index test [7], the energy requirements of processing PO and FR code samples require greater energy consumption than the GL and KA code samples. Another consequence of this difference in energy consumption has an effect on determining the design of the grinded equipment [6], which is of course if the alteration type of gold ore vein is far more than the low alteration gold ore vein, it would be more feasible to choose based on the most alteration type of gold ore vein, so more efficient in energy use. Although it resulted in a decrease in grinding production per unit time for low alteration types of gold ore, the overall combined production of the two types of gold ore veins can be achieved.

Acknowledgement

We say thank to LPPM Universitas Islam Bandung for funding this research.

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