THE ENVIRONMENTAL STUDY OF GOLD MINE IN GUNUNG MAS, WONOGIRI REGENCY

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Abstract

The gold mining and the processing in Gunung Mas Wonogiri area have been making machinery approximately since more than fifty years ago by the local communities. According to this study, it was aimed to perceive the process of mining, processing and the potential impacts which could be happen in surrounding operation mining location, either in the inside or outside the mine. Regionally, this location is the eastern part of the Southern Mountains of Java Island, and according to the rock units composition of this area, it includes Mandalika Formation. Landform is dominated by mountainous with steep to very steep slopes, with lots of outcrops and stones covering soil surface, the soil development was very complex with dominant soil type was a Lithosols, but also some developed soils of Latosols that were identified. Hydrothermal alteration process that had been going on these rocks then it generated potential gold reserves. The mining processed was used open pit and underground techniques, then the result of product mining or called mining production material was processed with amalgamation process to generate gold by the native regency. Those processes were not acquired the mining rule procedure yet properly which it could spark a worse environment potential effect in around exploitation area either on-site or off-site the mining area.

Keywords: small scale gold mining, Gunung Mas, environment

INTRODUCTION

The gold mine potential in Wonogiri regency has still offered expectation for economic development, including in the area of Gunung Mas. Related with the regional geology, the area of Gunung Mas is the part of the Southern Mountains of Java Island. This area was controlled by the strike-slip fault then it was intruded Andesite intrusion, thus there are many of prevalent rocks alteration. The alteration encountered are A. argillic, Propylic, Silica. On the other side, the precipitate seeds found in the area are gold and galena. As a result of the strike-slip fault and intrusions created the quite steep topography and the rock resistance seems obviously different in the area.

Gold mines in the Gunung Mas area have still good prospects for major income local communities. The mining activities in this area have been done by people since over fifty years ago. The local communities' skills to estimate the gold potential reserves of gold was elaborated from the ancient people, and then subsequently it was learned to the next youngest generation. The ability to mine and process to obtain gold has not been matched with the skills and awareness to reclaim the land mines and the waste treatment processes. The Mine wastes can be a poison which can spread through the flow of surface water, thus it contaminated the soil and the groundwater. According to that case, it was similar with the mining land in South Morocco Marrakech, where rivers and soil contaminated by copper (Cu) and zinc (Zn) from the weathering of minerals for instance: pirrotit, sphalerite, galena, chalcopyrite, arsenopyrite, pyrite and magnetite. The pH of the river ranged from 2.1 to 2.6, it made the pH river very acidic (El Khalil and El Hamani, 2008).

Hydrothermally, in an environment of alteration which produced gold ore, was found associated minerals that have the potential heavy metals contamination, including cinabar (HgS) (Novotny and Olem, 1994) Sphalerit (ZnS), wurtzite (ZnS), chalcopirite (CuFeS) and galena (PbS). Besides, the processing or amalgamation that was used is mercury water (Hg) that has the potential to increase the content of heavy metals in the environment on-site and off-site the mining area. Therefore, in this study aimed to identify the procedure of

mining and the mining process, also the organised land in the local mining, Boto Jatiroto village, Wonogiri Regency.

MATERIAL AND METHOD

This research was conducted in Gunung Mas area which is an area of local mining or artisanal and small-scale gold mining. This research area is located in the village of Boto, Jatiroto, Wonogiri. The stages of this research are: (1) the study geological maps , topographical maps, land maps, and the organized land, (2) conducted a geological survey to collect data alteration including the weathering igneous rock in which preceded with fractures, alteration sampled, and enrichment in fracture part and sampling, (3) conducted a land survey to determine general overview of the process of development land and the qualitative nature of the soil, (4) conducted a survey of hydrology to determine the pattern of water flow and the distribution of surface water, (5) conducted a survey the organized land to determine land use in the environment on-site and offsite the mine operation, (6) conducted site surveys of mining and processing sites (spindle) to determine the pattern waste resources of distribution mining and processing. All survey results are presented in the figure data to provide an overview of the environment study area.

RESULTS AND DISCUSSION

Regional Geology

The area study is the eastern part of the Southern Mountains of Java Island, in part Mandalika Formation. Having the stratigrafy sequence of the Southern Mountains of Java Island is Wungkal Formation limestone, Kebo Butak, Mandalika, breezy, Ngelanggeran, Sambipitu, Oyo, Wonosari, Kepek (Surono et al. 1992).

Formation Mandalika located in the Mandalika village, it has a thickness of between 80-200 m. This formation is composed of basaltic andesitic lava, porphyry, petite, rhyolite and dacite; dacite, andesite lava, dacitic tuff with dioritic dyke; dacitic trachytic basaltic andesitic lavas and andesitic breccia that were pyrophyllite; andesite, dacite, volcanic breccia, crystalline limestone; breccia, lava, tuff, with intercalation of sandstone and siltstone that show characteristics of sediment. This unit has the fingering facies within Tuff as Member of Kebobutak Formation.

Secondary Structure that evolved in the research area reverse strike-slip landscape that has a relative trending direction north-south and has a relative vein towards the west-east. There are different types of hydrothermal alteration according to the Guilbert (1986) it based on the divided by Meyer and Hamley (1967), among others: potassic, propylitic, serisitik, argillic, advanced argillic, greisen, and skarn. The hydrothermal system can be defined as the heat fluid circulation of (50 ° to> 500 ° C) though laterally and vertically at the variance of temperature and pressure in the subsurface (Pirajno, 1992). This system contains two main components of the heat source and the fluid phase. The circulation of hydrothermal fluids caused the assemblage of mineral on the rock wall becoming unstable, and trending to adapt with new balance forming minerals that suit to the new conditions as called hydrothermal alteration. Hydrothermal ore deposits are formed due to the circulation of hydrothermal fluids which can be leaching, transporting, and precipitating new minerals as the response to change in both physical and chemical conditions (Pirajno, 1992). The interaction between hydrothermal fluids and rocks in line (rock wall), will cause changing the primary minerals into mineral alterations.

Landform Characteristic

The research location is the part of mountains with the slope around 80% and is classified as very steep classification. The Landform surface that created steep slopes caused by runoff that form the groove and erosion, also the landslides in several locations. The source of water flow comes from rain water or spring water that have appeared from the top of the mountains and on the slopes of the mountains. According to the Soil Map Review

of Wonogiri Regency issued by Lembaga Peneltitian Tanah (LPT, 1966) the soil in the research area included in the Litosol deposition with source material of tuff and volcanic rocks. Giving the survey, the landform surface is encountered many outcrops and rocks on the surface (Figure 1). On the contrast, based on the field observations, it also found the weathering process and the forming soil process is enough thick, furthermore, there is a land that reaches a thickness around 2 m. Rocks on the land surface have many varies from small to very large sizes. Potentially, the existence of this rock is very dangerous in term of rock fall. Regarding to the classification of land capability and space utilisation, the research location should be as protected areas with the form factor of the slope.

Figure 1. Rocks at ground level

According to the history of landform, it was used for cultivation since quite long term time. Existingly, the landform used the top as a nature forest, a mixed gardening area, and the spread settlements pattern. In the middle of the mountains, the agricultural activities for rice cultivation was growth on the field with a slope of 80% with the terrace system, so that was made by a square method that makes up the bench terraces in direction of the contour lines. For irrigation of paddy fields, the farmers used various sources of water that came from the top flows as sub driver, and also the source of water that comes out on the slopes. The livestock local communities are commonly found consisting of cattle, goats and poultry (mainly chickens). The raising of cattle and goats by means of the stable, while the chicken is generally unstable. For homes that have a gold processing unit, with the amalgamation, are usually placed next to a goat or cow stables.

The main access of the village Boto is the road coming from the direction of Jatiroto then it ride down the slope to the road with the conditions of asphalt, concrete and macadam (stone structure) until the top of the mountain and then it cut by tops of the mountain towards the south as the border of the East Java Access road to every home residents to the main road with a road width of 1 m or walkway with a very heavy terrain. The main transport in the research area are using the motorcycle, the motorcycle owns every home. Having the purposing of water to meet the household needs through utilizing channeled into the individual plastic pipe to each settlement. Household energy needs are met by the country's electricity network.

Mining Location

Gold mine site located in a hilltop complex of Gunung Mas, which is called as Tapel by the rural community. The open-pit gold mines types, underground and open pit mine, it was followed by underground mining. The mining process used open pit methods in term of the generic that describes several methods of mining mineral deposits mine from the surface, which require landform clearing activities with the cleaning of vegetation, topsoil and rock or overburden on the mineral deposits from the surface and then followed by the reclamation of affected landform for post-mining land. The most imperative factor in determining whether the surface mining can be done at this time is the economic and the technical price for the products, the production cost, the quality and quantity of deposits, the overburden volume to be moved per ton of the deposit, and the feasibility of reclamation. The open pit methods that processed local community of Boto is clearing the ground by cutting trees and vegetation, digging and extracting material that contains a gold prospect.

This case is caused the presence of the mineral prospect gold contents, it is only around one meter below subsurface, that makes the local community in Boto village easily opened the overburden. The mechanical gold mining with open pit techniques by using the manual and the simple equipment. The shorted material that contains gold prospect is using water coming from the source water. Having the provision of mining technique that has been owned by the local communities, they do mining collectively and interchangeably. To reduce sediment transported by surface runoff water and sorting of returned prospect materials, they made a mini settle pond.

Having, the panoramic surface is an excavated irregular. This issue caused the quarrying activities carried out only in the main point locations that have acquired mineral prospects which have gold composites. Furthermore, there is undeveloped reclamation process to improve the environment in the mining trace area. Besides, they still have an assumption that the open pit mining is still very narrow in compared with the wide surrounding area for instance forest and field.

Beside of the mining with open pit technique, they also conducted underground mining by making holes in the points of gold prospect. The holes location is the location which predicted and estimated the present of the alteration in the form of mineral veins that contains gold. Thus, in Boto village found many holes underground mining, either still active or no- active.

The agreements schedules and groups of miners are proposed, thus the mining activity passed and executed socially and harmony.

Process logs

The mining result, both with the open pit and underground mining, it was put into sacks and then it was transported by motorcycle. In this village, there are 20 production units to acquire the gold. The unit processing of gold in the village called as gelundung which form was set cylinder using a dynamo with electric drive. In the processing, the material is made of split, then it inserted into gelundung plus water, mercury and leaves, such as lamtoro leaves. The process uses the gelundung rotator with electricity and lasts for 2 hours and then it was fed and the result is an amalgam. The wasting water is collected in a bucket and then it was used again for amalgamation process.

Generally, the amalgamation process is twice. Once formed amalgam, the next process is separating the burning gold with mercury water. The process is done by local people with amalgam burning in the flame. In the past, they did this separation in the cooking pot in the kitchen. But after knowing the risk to get large and potentially hit against all members of the family contamination, then they changed the process outside the home. The toxic metals are dangerous to the human health (Mudgal et al., 2010).

The waste material which was generated by the amalgamation process is liquid waste and solid waste. The liquid waste after the deposition process is simple then it was discharged into waterways. On the other hand, for solid waste or tailing was put in the tubs or just stacked. Having the drying, ii was teiling stored in sacks. There are businessmen from outside the area that collect waste then it was collected and processes the gold to be able to recover the Hg, thus it can be retrieved.

Figure 2. Logs amalgamation process

Generally, the spill waste in the term of colloidal teiling, water and Hg amalgamation process flow and inside into surface water bodies in the form of the flowline. Gravity, the major water is flowing into larger streams and into smaller streams. In the middle and bottom

of the stream mountains, the smaller steams come into the field as the irrigation water. Thus, potentially, the source of irrigation water also contains the contaminant of heavy metals.

Potential Impact

The potential impact of gold mining in Boto village can be divided into two, namely the impact on on-site and off-site (Figure 3). The impact on the on-site is assessable by changing that occurred in the area of mine and the area of logs. The mining area with the open mining techniques impacts in changing in biophysical, particularly: (1) changing in landform covered the vegetation becoming opened without vegetation, (2) the ground surface harassment, (3) changing in microstructure relief of the flat into holes, (4) removal land for stripping then it was not saved to reclamation to the pits. The impacts of off-site open pit mining at the site of the village of Boto are: (1) the collected of rain water in the pits causing the subsurface flow or subsurface runoff because the land has a very steep slope, thus there are the potential landslides, (2) the stream sediment carried away by the water which was used for mining process that caused soil erosion, and (3) the alteration element of rocks are dissolved into the runoff water that it could potentially contaminate the water and soil in the undermining area of fish ponds and rice paddies.

The impact that can be caused to the off-site to the gold mine in the village of Boto can be wider because the position of the mine area is located in the mountains, thus the water that can transport material and contaminant material can be spread to the location at the bottom which is regionally passed streams from smaller to larger.

For the underground mining process of mining was done by the local community in Boto, it brings impact to (1) the holes formation in the ground or slope wall, and (3) trace hole pits has a potential hazard to people or animals that passed through the mainly hole that had covered with vegetation. In addition, the off-site impacts of gold mining in this village with underground mining methods have the potential for subsurface flow accumulation passed the pits.

The potential risks which were rose by the impact of the amalgamation process are contamination in the off-site and on site area. In the on-site area can be contaminated with soil, water, plants, humans, and livestock which managed by the communities. This case is due to the amalgamation process that made at home or in the behind house yard which is also adjacent to the enclosure of goats or cattle, poultry and animal communities. The risk of impact can be caused to the offsite area of both locally and regionally since the amalgamation area is the part of South Mountain slopes and there is a flow of water from upstream of the water then it flows in the form of coalescing into a larger flow. In addition, the water from stream and tributaries stream are used for water irrigation in the fields around the bottom area, thus the potential for spreading the contaminants to the productive land is cultivated communities to produce food. The potential impacts in off-site are the liquid waste amalgam process that could potentially pollute the land in the under cultivation location.

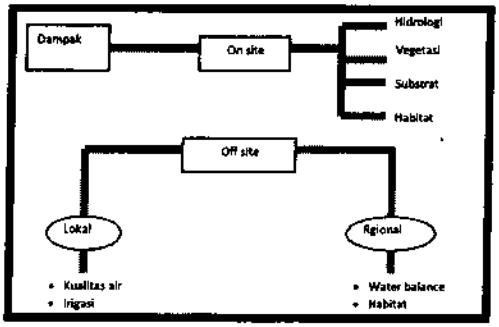

Figure 3. Potential environmental impact

CONCLUSION

Boto Village, Jatiroto is the part of the Southern Mountains of Java Island located in Wonogiri, Mandalika Formation. Hydrothermal alteration in this area yields a potential source of gold mining material which is processed by the local community. Mining industries have been already operated since approximately more than fifty years ago, with the mining and processing techniques did not

meet the standard operation rules. In addition, there is no consciousness to reclaim mining and manage waste processing (amalgamation). This case has a potential occurrence of environmental problems for instance contamination of soil, water, plants, animals and humans in the on-site n and off-site in the mining area. This case needs profound research to determine the type of contamination and the good ways of tackling this issue that can reduce environmental problems in this mining operation area.

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