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Mercury Reduction on Gold Extraction in Artisanal and Small-Scale Gold Mining. A Case Study in Pelangan Village, West Nusa Tenggara Province, Indonesia

Mercury Reduction on Gold Extraction in Artisanal and Small-Scale Gold Mining. A Case Study in Pelangan Village, West Nusa Tenggara Province, Indonesia

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Abstract. The most common method used for gold processing in artisanal and small-scale mining is amalgamation using mercury as a gold extracting agent. Indonesia is one of the countries that ratify the Minamata Convention, meaning that Indonesia has agreed to reduce or even eliminate the use of mercury. Some methods for replacing mercury as a gold-extracting agent are cyanidation and borax. The research aims to determine whether the miners in Pelangan still use mercury in gold processing. The method of this research is observation, interviews, and literature review. The data obtained were then analyzed descriptively. The result indicates that the miners in Pelangan Village use two methods of gold processing from ore: (1) amalgamation using mercury followed by cyanidation and (2) cyanidation. Most of the miners use the cyanidation method without going through amalgamation. The main reason they do not use mercury are amalgamation method yields low gold recovery and the price of mercury is high. This indirectly shows that the miners in Pelangan Village have contributed to efforts to reduce mercury use in Indonesia.

1. Introduction

Artisanal and small-scale gold mining (ASGM) is generally described as low-technology gold extraction [1]. ASGM has a positive impact by providing jobs for many people to improve their welfare. Therefore, community mining activities that previously did not have a permit were upgraded to licensedartisanal mining to minimize the adverse impacts brought by mining activities, especially environmentalpollution. The minimal recovery achieved, however, is another issue that significantly restricts the viability of community gold mining. This offers a compelling case for persuading miners to switch to more effective and ecologically friendly processing techniques. The impact of the pollution produced by mining activities on the environment and human health is explained to miners by some non- governmental groups and associations. However, they need more motivation to alter their practices bythis information. If they notice a negative influence on the local economy, miners may think about changing their habits [2]. Even though mercury is very poisonous [3], mercury amalgamation is still the therapy of choice in many ASGM areas [1].

Using cyanide in leaching procedures to recover gold has led to a change in mining practices in many nations. Using cyanidation as a substitute for mercury in gold extraction is known to improve gold recovery; nevertheless, because this material is improperly controlled, it is debatable how this complicated interplay between mercury and cyanide will affect the environment [4]. Cyanidation

technology first appeared in Indonesia around 2007. The introduction of cyanidation techniques made tailings from the amalgamation process a valuable resource—even a traded commodity. Previously, tailings were disposed of carelessly; now, tailings are collected and sold [1]. Amalgamated tailings contaminated with mercury will be processed by cyanidation to extract residual gold. In this process, about 80-90% of the gold in the tailings is usually recovered. [5]. South Central Peruvian artisanal miners refine gold using two different processes. Some people still utilize amalgamation first, then cyanidation, while others only use the cyanidation technique.

The pulverized ore is combined with cement at San Luis and other mills in the region, such Relave, to perform cyanidation. The miners add cement to promote porosity and prevent the agglomeration of very tiny particles, which helps the cyanide solution circulate more easily [2].

There are ways to extract gold without using mercury. One approach has been proven to be reliable and secure. The "mercury-free gold extraction process" involves smelting with borax and is known as such. Small-scale gold miners found a mercury-free gold extraction technique in the northern Philippine province of Benguet. The substance utilized as borax is sodium borate [5]-[7]. Because it reduces the melting point of gold and other metals, borax is employed in smelting. Recent research on the alleged toxicity of borax has revealed that there are no or very minor negative effects on health [8]. Around 15,000 small-scale gold miners in the Benguet region of the northern Philippines combine their gold concentrate with borax before heating and smelting it. As a result, the region uses relatively little mercury and the rates of gold recovery are remarkable [9].

Low gold recovery using amalgamation results in high economic losses for small-scale miners. More and more miners are aware of these disadvantages. Therefore, they often process amalgamated tailings with cyanidation, and more miners abandon amalgamation methods. Often, they switch to cyanidation. Rising mercury prices may also contribute to this change. Following cyanidation, the Hg content in amalgamation tailings is cut in half. On Lombok Island, Indonesia, researchers discovered comparable, almost 50% lower mercury levels in cyanidated tailings than in input amalgamated tailings [2].

The Minamata Convention to Reduce Global Mercury Pollution has been signed by a majority of nations, including Indonesia [6]. Therefore, the study aims to find out whether the miners in Pelangan still use mercury in gold processing today.

2. Method

The research was conducted in Pelangan Village, Sekotong Sub-District, West Lombok Regency, West Nusa Tenggara Province, Indonesia. Using the land route, it takes about 50 minutes to reach the research location from the city of Mataram. Mining activities in Pelangan village have been going on since 2008 until now.

The method of this research is observation, interviews, and literature review. Observations were made at several processing locations using amalgamation and cyanidation processes (*gelondong* and *tong*). Interviews were conducted with miners in Pelangan Village. The method of determining respondents using purposive sampling, namely miners. The number of respondents interviewed was 33 miners. The literature review was conducted by reading journals about gold processing technology at ASGM in several locations. The data obtained were then analyzed descriptively.

3. Results and Discussion

Gold ore processing in Pelangan Village generally uses amalgamation and cyanidation processes. In the past, when mining just started around 2008, most of the miners used the amalgamation process. Over time, miners began to utilize the tailings for further processing by cyanidation. The ore, after being crushed, will mix with the mercury (amalgamation). Gold will bond with mercury to form an amalgam. Sludge or tailings remaining from the amalgamation process will be collected for further processing by cyanidation. Nevertheless, now, the miners have started to reduce the use of mercury. One of the main reasons is the high price of mercury in the market. In 2008, the price of mercury was around Rp. 700,000/kg. Currently, the price of mercury is around Rp. 1,800,000 – Rp. 2,000,000/kg. This makes the miners analyse profit and loss before using the amalgamation process. They will use the amalgamation process if the ore is estimated to have a high gold content. With the hope that the gold

obtained is worth higher than the price of mercury used. However, if the mined rock is estimated to have a low gold content, the logs will only be used to reduce the size of the rock (refining rock), and then process it by cyanidation in tanks (locally called *tong*).

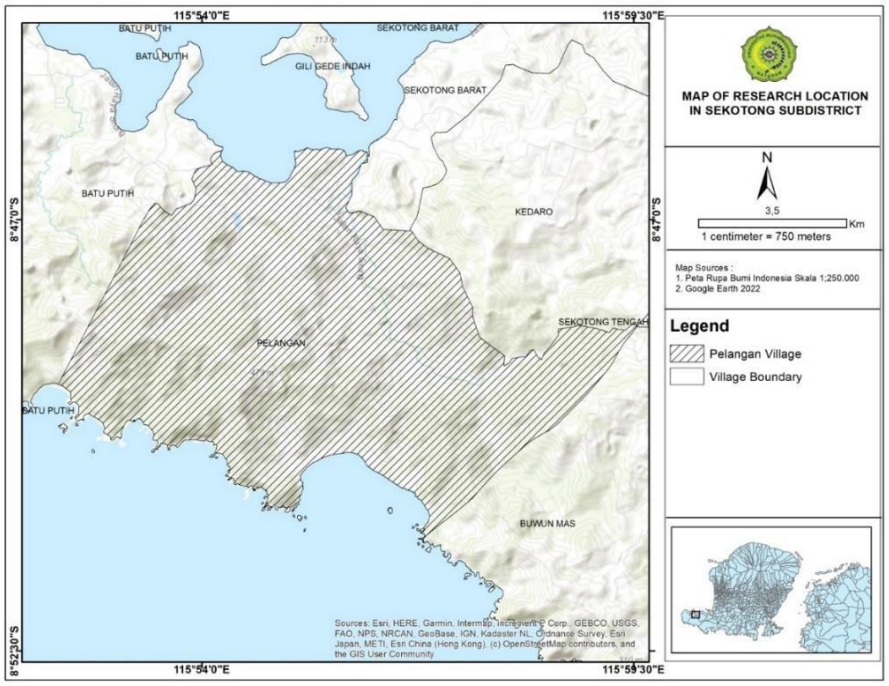

Figure 1. Research Location in Pelangan Village

The cyanidation process takes a longer time than amalgamation using mercury. In Pelangan Village, one cyanidation process takes three days. The ingredients added are activated carbon, limestone, and cyanide (NaCN). The average tank capacity is about 85 bags of tailings. The cyanidation process also requires a large amount of money, around Rp. 3.750.000/tong/batch. This is because not all miners can make cyaniding tanks (*tong*), so miners pay rent for using tongs to carry out the cyanidation process. The rental price includes the price of activated carbon, limestone, and cyanide used for the cyanidation process.

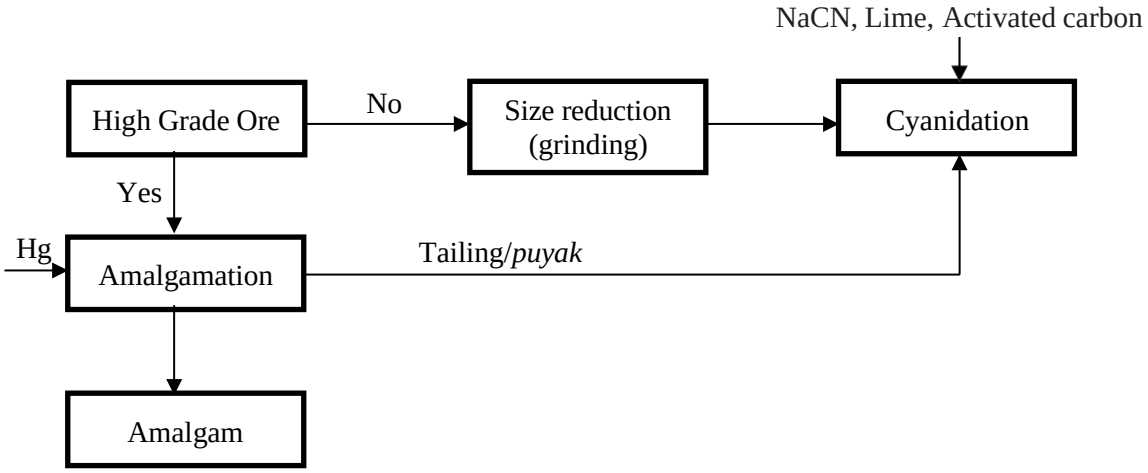

Figure 2. Gold Extraction in Pelangan Village

Cyanidation is currently the method that amalgamation is being replaced by most frequently. On the other hand, it is not the most environmentally beneficial method, particularly when amalgamation tailings are used. Both humans and the environment are highly hazardous to cyanide [2]. The

cyanidation of mercury-contaminated tailings produces the dangerous cyanide-mercury combination $[Hg(CN)4]^{2-}$ in North Sulawesi, Indonesia. However, by utilizing it as a significant supply of nitrogen and carbon, some bacterial species may convert cyanide in both aerobic and anaerobic environments. Aerobic biological processes will break down cyanide in the presence of microbes and oxygen. Anaerobic mechanisms are also used to naturally break down cyanide, but much more slowly [4].

Many artisanal gold mines recover gold using the clean technique of gravity concentration; nevertheless, miners frequently combine amalgamation with this concentration technique. Thus, the consumption of mercury is decreased but not completely stopped. Borax-based gold recovery is one of the techniques employed by miners. The only health risks linked with using borax to extract gold are caused by the dust produced, which solely irritates the eyes, throat, nose, and skin. Tailings and low-grade gold ore are considered candidates for gold phytoextraction. Gold recovery in amalgamated tailings from artisanal mining operations in Indonesia was explored [2]. To enhance ASGM practices, the Indonesian government, foreign organizations, and other stakeholders must take the necessary steps. Alternatives to amalgamation that are technical in nature include cyanidation, flotation, magnetic separation, gravity concentration, and phytoextraction. It takes time to develop the technical solution to be chosen, which is the duty of all players and stakeholders. Practical solutions include multi-level stakeholder involvement, ongoing communication, training, and education [10].

4. Conclusion

Although the cyanidation method also harms the environment, cyanide can still be degraded by biological processes. So, to eliminate mercury use in Pelangan Village, gold ore processing in the village should change to using a pure cyanidation process without starting with amalgamation. This is to reduce the impact of the formation of a mercury-cyanide complex. The high cost of the cyanidationprocess makes it necessary for further research on the possibility of implementing the cyanidation process on *gelondong*. Other mercury-free processing technologies must also be introduced and socialized to the Pelangan village community.

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