23	Environmental engineer	GMT Co., Ltd.	The lucky local community who has natural Pb-resources around their areas can develop them for utilization in many ways. But the mining investors should have the suitable processing to operate and protect its pollution problems. The local community must have the opportunity to cooperate with them for controling the Pb-pollution in the mining processes. And the government should has a strick law and strong punishment for everyone who broke its.
24	House maid	Municipe of Tambon Thong-Phaphum	We don't want any mining activities around Thong-Phaphum areas.
25	Assistant	Municipe of Tambon Thong-Phaphum	We can not trust the mining investor about their mining & processing methods because they have many tactics which the local people can not flollow them. Anyway, the goverment should have laws and officers to look after the Pb-pollution around their mining areas.
26	Villager	Tam Bon Chalare, Ban Kle	We want the seminar where the whole stakeholders can come to share their responsibility for Pb-pollution control around these areas. And the final seminar should hold in Amphoe Thong-Phaphum area where it is the original source of these problems but not in Bangkok.
27	Division of local Education promotion, Ministry of Education.		Don't agree to have mining investments in these Pb-resource areas because only very few groups of the investors who take the whole profit but the local community was the real victim of the Pb-pollution. In long-term mining investment is not economic when compare to the health hazardous of many generations of our local people and they also destroy many surrounding environment of soil, stream water, mountain, forest and etc.
28	Villager	Tam Bon Chalare, Ban Pu	Mining investment brings many profit and income to their local community but they must have to operate without causing any Pb-pollution to contaminate into their surrounding environments.
29	Officer	Kanchanaburi Exploration & Mining Co., ltd.	We want mining investments in this area because it brings income to develop many of our local community structures such as road, school, local funds and hospital.
30	Chief of local Administration Governer	Municipe of Tambon Thong-Phaphum	We can not accept the mining investments in this area because they brough many problems to our local community.
31	Chief of National Park	Lamkhlongngu National Park (Thong Pha-phum)	1. In the preservation and conservation areas, we can do not thing then it is better that we continue to keep them as their original stage 2. Outside the preservation and conservation areas, we can develop with good management and best protecting the pollution problem not to disturb their surrounding environment.
32	Teacher	Ban Song-Toh School	We agree to continue mining investments in these areas. Because it brings good things to our local community than bad things.
33	Member of Thong-Phaphum Commercial Center	Municipe of Tambon Thong-Phaphum	1.Minerals resources are the up-stream industries then they are necessary to utilize them for using their income to develop our local community. 2.With the careful mining & processing processes, its can help to prevent the Pb-pollution not get into their surronding environment. 3. Besides, Pb-Zn minerals there are another minerals around these areas those we can develop and utilize them to better our local people community.
34	Villager	Tam Bon Chalare, Ban Kle	The Pb-deposits around Tam Bon Chalare area is high potential for mining investment and can brings many profit and income to their local community. It is useless to stop the mining activities around these areas. With good development and management of the mining and processing processes to prevent their Pb-pollution not get out to contaminate into their surrounding evironmen then the local community want to support their mining activities. They should have to educate their local community to concern about the health hazardous from the Pb-pollution and teach them to know how they can have practical protection methods.
35	Chief villager of Ban Huai Sue	Tambon Chalare	From the assessment of mining activities in these areas, it proved that if the mine caused no waste products of Pb-content to conaminate into their surrounding environment then the local community can accept them. But the mines should employ our local people to work with them not the outsider workers. The people who have already invaded to live in the mining areas, the owner of the mine should not dismiss them to get out.
36	Villager	Tam Bon Chalare, Ban Pu	The local community would like the DMR to take good care of Pb-resources in these areas and also grateful for their responsibility for controling the Pb-pollution not to contaminate into their surrounding environment.
37	Kanchanaburi Exploration & Mining Co., ltd.	Tam Bon Chalare, Ban Son	The development and management of many sections in our local communities together with mining activites as the whole stakeholders of these projects have planing. If they are really practical then all are acceptabe to let them to continue their mining investments.
38	Senior Mining Engineer	Department of Industries ar	It can not confirm that in the mining areas their local community can also get profit from their agriculture products.
39	Senior Mining Engineer	Department of Industries ar	Three of the alternative choices make confuse for understanding. They should clearly expain that 1.) Preservation areas mean we want to preserve them permanently as their original forms without usage from today and in the future. 2.) Conservation areas mean we want to conserve them for develop whenever they are necessary in the future. 3.) Development areas mean we can utilize our natural resources as our purposes but we must have the practical processes to control its pollution.
40	Mining Engineer	Division of Strategic and Promotion mining sector of DPIM.	When we have a good development for getting maximum profit and sustainable management from our natural resources for our local community, so each given alternative choice is best for those whole stakeholders and it is better than let it goes by haphardus.
41	Senoir Environmental Control	Office of Ecomonic and So	The government should have to declare a clearly understanding of three kinds of land rights for the local people to know their autorities for using them. Such as 1.) "State owned property":- Where these areas all of the people are their owner and no one can use it for individual profit only. Everyone should help to look after their ecology or surrounding environments with carefulnessly. 2.) "Public property":- Where each public sectors are their owner and can utilize them for the public usefulness only, they have to compensate with fair and justice to their public stakeholders and must have to rehabilitation them after finished their usage. 3.) "Individual property":- Where every person has their land right and can utilize from their resources as their own. With the combination of these three property principles as the "Property Law" for their local community, it can help to develop their natural resources with maximum profit and sustainable management for all of them. We should also apply the environmental management of Japan to use in our areas, where they have "Voluntary Agreement of Each Local Community". Those voluntary agreement are consisted of local community, government officers and the investors. These three parties make an agreement to develop their natural resources with the maximum profit and sustainable managemen for the whole stakeholders by the "Environmental Control Division" supports the knowledge of how to preserve, conserve, develop and manage their natural resources with the practical processes to control the pollution.

Table 3 Continued

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Artisanal and small scale Gold mining in Gorontalo Utara regency, Indonesia

Yayu I. ARIFIN[1,2], Masayuki. SAKAKIBARA[1], Sayaka, TAKAKURA[3], Mohamad. JAHJA[4], Fitriane LIHAWA[5], Marike MACHMUD[5]

1: Graduate School of Science & Engineering, Ehime University, 2-5 Bunkyo-cho, Matsuyama, 790-8577 Japan e-mail: yayu_arifin@ung.ac.id

2: Department of Geology, State University of Gorontalo, Jl. Jend. Sudirman No. 6 Kota Gorontalo, 96128 Indonesia

3: Institute for International Relations, Ehime University, 3 Bunkyo-cho, Matsuyama, 790-8577 Japan

4: Department of Physics, State University of Gorontalo, Jl. Jend. Sudirman No. 6 Kota Gorontalo, 96128 Indonesia

5: Department of Educational Geography, StateUniversity of Gorontalo, Jl. Jend. Sudirman No. 6 Kota Gorontalo, 96128 Indonesia

Abstract

Illegal mining activities in Gorontalo utara regency are part of nation wide rush gold mining in Indonesia. Mercury pollution from gold mining site of Indonesia has been icreasing for last 5 years). In Gorontalo province there are at least one gold mining site at each regency, except Gorontalo city. In Gorontalo Utara regency there are two ASGM sites namely Hulawa, Ilangata and Ilangata Barat. The ASGM activities in Hulawa has been started from dutch colonial era (about the beginning of 20th century), while in Ilangata and Ilangata barat are just started recently (about 3 years ago). But the description of how much mercury emission from gold mining sites in Gorontalo utara has not been reported yet. The purpose of this study is to determine the mercury released to the environment from gold mining sites in Gorontalo utara regency. Informations on mercury released from gold mining sites to the environment are obtained by direct interviews with owners, miners and local government staffs. Mercury is used to amalgamate the gold from the ore, there are several techniques available. We estimate that ilegal gold mining activities in Gorontalo Utara regency releases about 572 kg of mercury per year. The mercury releases directly to the environment and contamintes the soil, waters and air. Several mining activities like crushing and recovering gold from wastes involving woman and children workers. Woman and children involvements in the mining activities such as mining waste processing and panning.

Key Words: *Illegal gold mining, Gorontalo utara, mercury emission, woman and children workers*

Introduction

According to the Arctic Monitoring and Assessment Programme (AMAP, 2008) there are 115 ASGM industries in Indonesia that collectively produce 60 t of Au per annum. These activities are distributed evenly throughout the whole country. The number of ASGM sites and miners in Indonesia are estimated to be ca. 900 and 250,000, respectively (Purwana, 2013).

Many ASGM sites exist in Sumatra, particularly the Ulu Masen site of Aceh where 3000 miners are working, as well as the Batang Gadis site in northern Sumatra (Midora, 2006) and Way Linggo site of Lampung. Major ASGM sites in Java include Pongkor in west Java and Trenggalek and Tumpang Pitu in east Java. The Sekotong mining area is one of the largest ASGM sites on Lombok Island where the Hg soil content reaches levels of up to 1000 ppm. The organic form of Hg (methyl Hg) has also been found in rice (up to 100 ppb) and miners hair (up to 1000 ppb) (Krisnayanti et al., 2012).

The situation in Kalimantan is even worse, even though there is only one reported ASGM site. However, this site is large (43,000 miners) and collectively produces 13.3 t of Au and uses 65.3 t of Hg per annum (Stapper, 2011). Health assessments in this region have revealed Hg levels of up to 224 ppm in miners hair (Bose-O'Reily et al., 2010).

The largest Au mining site is of Indonesia located in eastern Indonesia, and the tailings from this site are dumped in Mimika. In northern Maluku, there is large-scale Au mining in Gosowong on Halmahera Island. ASGM activities take place in Gunung Botak of Buru Island, Maluku Province. Several ASGM locations have been reported in Sulawesi, including Poboya in Palu, which is the capital of central Sulawesi (IPEN, 2013). At this location, 100 t of Hg is used

annually (IPEN, 2013). There are four ASGM locations in northern Sulawesi, at Talawaan (Bose-O'Reilly et al., 2010), Buyat (Limbong et al., 2003; Kambey et al., 2001; Lasut et al., 2010), Tabongan and Tanoyan in Bolmong. The Hg emissions from Talawaan alone are 100 t per annum (Bose-O'Reilly et al., 2010).

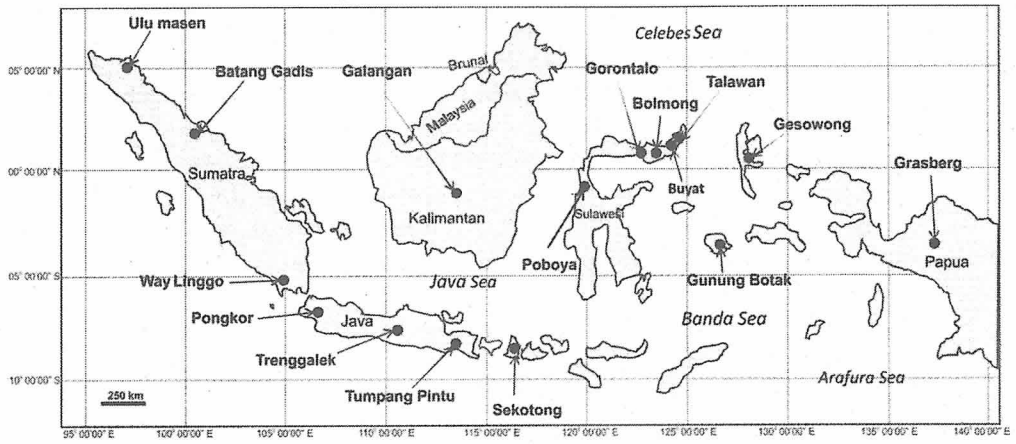

Figure 1. Major gold mining locations (black circle) in Indonesia

In Gorontalo Province, we were able to identify at least one ASGM site in each regency: (1) Pohuwato regency: Gunung Pani and Bulontio; (2) Boalemo regency: Bilato; (3) Bonebolango regency: Tulabolo; and (4) Gorontalo Utara regency: Hulawa and Ilangata villages. The aim of this study is to describe the Hg pollution at illegal mining sites in Gorontalo Utara regency. These estimated Hg losses and descriptions of working conditions and social activities of mine workers provide important data for understanding the health hazards associated with these mining activities.

Materials and Methods

Data about Hg use in ASGM and the activities of miners and their families were obtained from direct interviews with miners, mine owners, and local government officials.The interviews were conducted on-site at the mining locations in the Gorontalo Utara regency (Fig. 1). Both mining areas has a typical equatorial climate with two seasons (rainy: November–March/April; dry: May–October), with the highest rainfall occurring in December (annual average, 1210 mm).The annual average temperature is ca. 27℃.

The Hulawa (meaning 'gold' in the Gorontalo language) mining area is also known as the Buladu mining area in Sumalata. The area lies within the Buladu River watershed, between Pasolo and Padengo villages, and ca. 109 km northeast of Gorontalo City, which is the capital of Gorontalo Province. This area can be reached by car from Gorontalo city in 2 h 15 min. The Buladu River watershed drains from the mountain peaks (highest point = 2000 m) into the northern coast of Sumalata district. The distance from the mountain peaks to the Sulawesi Sea is ca. 10 km. Several rivers run through the watershed, including the Buladuand Wubudurivers.

In Gorontalo Utara regency, the Ilangata and Ilangata Barat mining area is also known as the Anggrek mining area. This area lies within the Anggrek River watershed between Diata, Lunggulo, and Lantolo villages, which are ca. 68.4 km northeast of Gorontalo City. This area can be reached by car from Gorontalo City in 1 h 20 min.TheAnggrek River watershed drains from the peaks of several hills (highest point = 300 m) to the eastern coast of Anggrek district. The distance from the peaks to the sea is ca. 5 km. A number of rivers flow through the Anggrek watershed, including the Anggrek and Ilangata rivers.

Results

The amalgamation process is the basic Au production method used by miners in Gorontalo Province (Fig. 4). The mining system is the same as that used by underground mining given the nature of the primary ore. Ore is excavated and

transported manually from nearby hills or mountains to the processing sites. Traditional tools such as broad hoes, craws, and bars are used to carry out ore excavation. The ore is then packed into sacks and manually transported to the processing plant. In the processing plant, the ore is manually crushed using hammers or other percussion tools, although some processing plants use home made mechanical crushers. Crushed ore (30–40 kg) is fed into a trommel mill with water and several decimeter-sized rocks and milled for 3–4 h until the material is fine enough to release Au. Subsequently, ca. 500 g of Hg is added to the trommel, which is then rotated for 30 min until amalgamation has been completed. The involvement of women and children workers is unique to the Hulawa mining site, where they come from neighborhoods such as the Buladu area. These workers are found working with waste stored in ponds and undertaking sluicing and panning in the Wubudu River estuary.

Data are estimated using information from the miners that each cycle, one trommel mill can be fed with ca. 30-40 kg of crushed ore and 0.5 kg Hg needed to extract the Au. Assuming that all trommel mills are operating in each cycle, 275 kg of Hg is needed. From these data and amount of Hg lost per gram of Au produced, we can estimate the Hg loss to the environment. From each primary cycle, ca. 3 g of Au per trommel mill is produced, whereas secondary processing of waste produces ca. 0.5 g of Au per trommel mill. We also assume that the miners only work five days a week, given that they sell the Au on Saturday, and that the ratio of Hg loss to Au produced is ca. 2:1 (Darmutji, 2003). The amount of Au produced in each cycle is ca. 378 x 3 g or 1134 g, which results in a calculated Hg loss of ca. 2 x 1.1 kg or 2.2 kg per cycle. Since the miners works five days only a week and there are 52 weeks a year, then the total annual Hg loss in the Gorontalo Utara regency is ca. 2.2 kg/day x 5 days/week x 52 weeks/year or 572 kg.

Conculusion

ASGM activities in the Gorontalo Utara regency have been described as being illegal and dangerous to the environment, miners, and local population. The amount of Hg used per mining cycle is ca. 275 kg, and the Hg lost per cycle is ca. 2.2 kg. Annually, ASGM in the Gorontalo Utara regency produces 286 kg of Au and emits 572 kg of Hg. This is probably aconservative estimate given the limited mining data available. The impact of such large Hg losses to the environment and people needs to be assessed, particularly given that the Gorontalo Utara regency is an important agricultural (rice) and horticultural (dairy) production area for Gorontalo Province and Indonesia.

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日本語要旨:

インドネシアゴロンタロ州における小規模金採鉱について

ヤユ I. アリフィン[1,2]・榊原正幸[1]・高倉清香[3]・モハマド ヤヒャ[4]・フィトリアニ リハワ[5]・マリケ マフムド[5]

1:愛媛大学理工学研究科　〒790-8577　松山市文京町 2-5　E-mail: yayu_arifin@ung.ac.id

2:ゴロンタロ大学地質学科　Jl. Jend. Sudirman No. 6 Kota Gorontalo, 96128 Indonesia

3:愛媛大学国際連携推進機構　〒790-8577　松山市文京町 3

4: ゴロンタロ大学物理学科　Jl. Jend. Sudirman No. 6 Kota Gorontalo, 96128 Indonesia

5: ゴロンタロ大学教育地理学科　Jl. Jend. Sudirman No. 6 Kota Gorontalo, 96128 Indonesia

インドネシアでは，金鉱山の採掘が盛んで，北ゴロンタロ県における違法金鉱山も増加している．過去五年間における金鉱山による水銀汚染は増え続けている．ゴロンタロ州では，ゴロンタロ市を除き，各郡に少なくとも一箇所以上の金鉱山がある．北ゴロンタロ県には二つの小規模な違法金採鉱サイト（Hulawa、Ilangata）がある．Hulawa では 20 世紀初頭のオランダ領のころから，Ilangata ではここ 3 年のうちに採掘されている．しかしながら，鉱山からどの程度の水銀が環境中に放出されているかの報告はない．本研究の目的は，北ゴロンタロ県の金鉱山からどの程度の水銀が放出されているかを調査することである．鉱山のオーナー，鉱山労働者や地元政府への聞き取り調査によって，年間 572 kg の水銀が周辺環境へ放出されていると推定された．また，いくつかの鉱山では女性や子どもも働いている．

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Anthropogenic mercury contamination and geology of Mongolia

B.TUMENBAYAR[1], S. MURAO[2], T. MAIDAR[1], J.URAMGAA[1] and K.SERA[3]

1: Sans Frontiere Progres, NGO, P.O.Box 46 / 468, Ulaanbaatar-46, Mongolia e-mail: btumenbayar@yahoo.com

2:Institute for Geo-Resources and Environment, AIST. Higashi 1-1-1,Tsukuba, Japan 305-8567

3:Iwate Medical University Cyclotron Center, Tomegamori, Takizawamura, Iwategun, Japan 020-0173

Abstract

Anthropogenic mercury contamination in Mongolia isfound within the gold bearing zones, especially of artisanal/small-scale gold mining (ASGM), where mercury is used for gold extraction by amalgamation. The contamination status and its environmental and human health impacts are differ in northern and southern Mongolia according to the country's geological and geographical features: mercury evaporation from waste tailings in the north Mongolian forest - steppe area is relatively lower than in south Mongolia. Mercury released from waste tailings is usually absorbed and accumulated in the soil and deposited in the different underground layers. The metallic mercury typically penetrates in soil at 0 - 5 cm per year, depending on the mineral composition and structure of the soil/sediment. In the dry and sandy Gobi area, i.e. south Mongolia, soil is heated quickly up to 60^0-65^0C or even higher, and the most of the mercury in surface layer is released into the air, and not much is left in the soil. This mercury-containing fog (similar to yellow dust) is driven by the wind and sometimes reach to neighboring aras. In the Gobi zone, especially in summer, the risk of mercury is much higher than northern forest-steppe zone of Mongolia.

Key Words: *mercury, dust, gold, contamination, Mongolia, artisanal/small-scale mining.*

Introduction

In Mongolia, mercury usage in mining both for hard rock and placer gold recovery began during the pre-revolutionary times and continued throughout most of the Soviet times. Since then tons of mercury were accumulated in tailings, most notably at the Boroo Gold Recovery Factory and in many other scattered locations throughout Mongolia. (Tumenbayar, 2000, 2001). The scale of the problem in north Mongolia became apparent with the results of a study funded by the Japan International Cooperation Agency (Tumenbayar, 2003). Meanwhile, artisanal/small-scale mining (ASGM) began to spread southwards reaching the Gobi Desert, and the mercury usage spread rapidly to many regions of Mongolia. Therefore the US Embassy became concerned at the need to alert local people to the mercury phenomenon in the Gobi and to determine the nature and extent of the problem, leading to the project U.S. Department of State Grant: SMG 10007GR008 (Tumenbayar, 2007) . An experience of Mongolian NGO *Sans Frontiere Progres* is shared in this report.

Anthropogenic Mercury Contaminated Sites and Gold Distribution

ASGM is one of the sources of anthropogenic mercury contamination in Mongolia (Figs. 1 and 2). ASGM workers called *Ninja* usually use large quantities of mercury to catch refractory gold by amalgamation. The amalgam is usually lumpy and can be recovered fairly easily. The amalgam is then heated to drive off the metallic mercury as mercury vapour pasuing health risk (Tumenbayar, 2007) . There are two main provinces of ASGM and its mercury contamination: (I) well known Khentei, Onon and Bayankhongor gold belts associated with Caledonian structure (north Mongolia) ; and (II) recently discovered Oyut-Tolgoi, South Altay gold belts on the uplifted blocks associated with Hercinian structure (south Mongolia).

Mercury Contamination and Environmental Effect

The impact by the mercury contamination to the environment and human health are different for these two provinces, reflecting the difference of geological and geographical features.

(I) In north Mongolian forest-steppe area, the number of days with temperature above zero on the ground surface is less than 190 days/year, (mercury evaporation starts above zero >0^0C temperature). During these days average wind speed per month is not