



(REVIEW ARTICLE)



Artisanal gold mining in guinea and security concerns

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World Journal of Advanced Research and Reviews, 2024, 22(01), 124–130

Publication history: Received on 22 February 2024; revised on 28 March 2024; accepted on 31 March 2024

Article DOI: <https://doi.org/10.30574/wjarr.2024.22.1.1039>

Abstract

One of the continents richest in gold reserves is Africa. According to the World Bank, about 20 % of gold in African countries is still mined using artisanal methods. There is no officially recognized, generally accepted definition of artisanal small-scale gold mining. In essence, artisanal or small-scale gold mining is a labor-intensive, financially and technologically underdeveloped gold mining activity. Artisanal gold mining can be either informal, illegal, without state permission, or formal (legalized, streamlined). In the modern world, artisanal mining in African countries is experiencing rapid growth after their liberation from colonial oppression. The paper examines the environmental costs or ecological footprint of artisanal gold mining, such as: mercury intoxication of ecosystems, gold miners and local populations; deforestation, destruction of ecosystems; pollution of watercourses; industrial injuries and occupational diseases of gold miners; crime and social instability. Practical recommendations for improving safety are given.

Keywords: Artisanal Gold Mining; Environmental Harm; Mercury Intoxication; Pollution; Industrial Injuries; Occupational Diseases.

1. Introduction

One of the first and most ancient human professions is gold mining. People began to mine gold even before our era, and for centuries this metal has been a measure of the well-being and wealth of individuals and states. Calculations show that if you add up all the gold mined on the planet, it will be a cube with an edge of 20 meters, and the mass of rock raised in this case will form a mountain 2.5 km high.

One of the continents richest in gold reserves is Africa, where gold mining began in the 5th century in Ghana and Mali, known in Europe as the “Gold Coast”, gold bars and coins were exported throughout the world. Africa has been the largest producer of gold for many years, and several African countries are among the world's leading producers (Figure 1). In Fig. Table 2 shows data on the dynamics of gold mining in the period from 2017 to 2021 [1].

According to the World Bank, about 20% of gold in these countries is still mined using artisanal methods, while in the Russian Federation artisanal gold mining is prohibited.

Currently, in the English-language literature there are three different concepts - artisanal gold mining, small-scale gold mining and artisanal and small-scale gold mining. These terms essentially define the same thing - a non-industrial, small-scale method of extraction. The only difference is that small-scale involves a larger scale of activity than artisanal [1].

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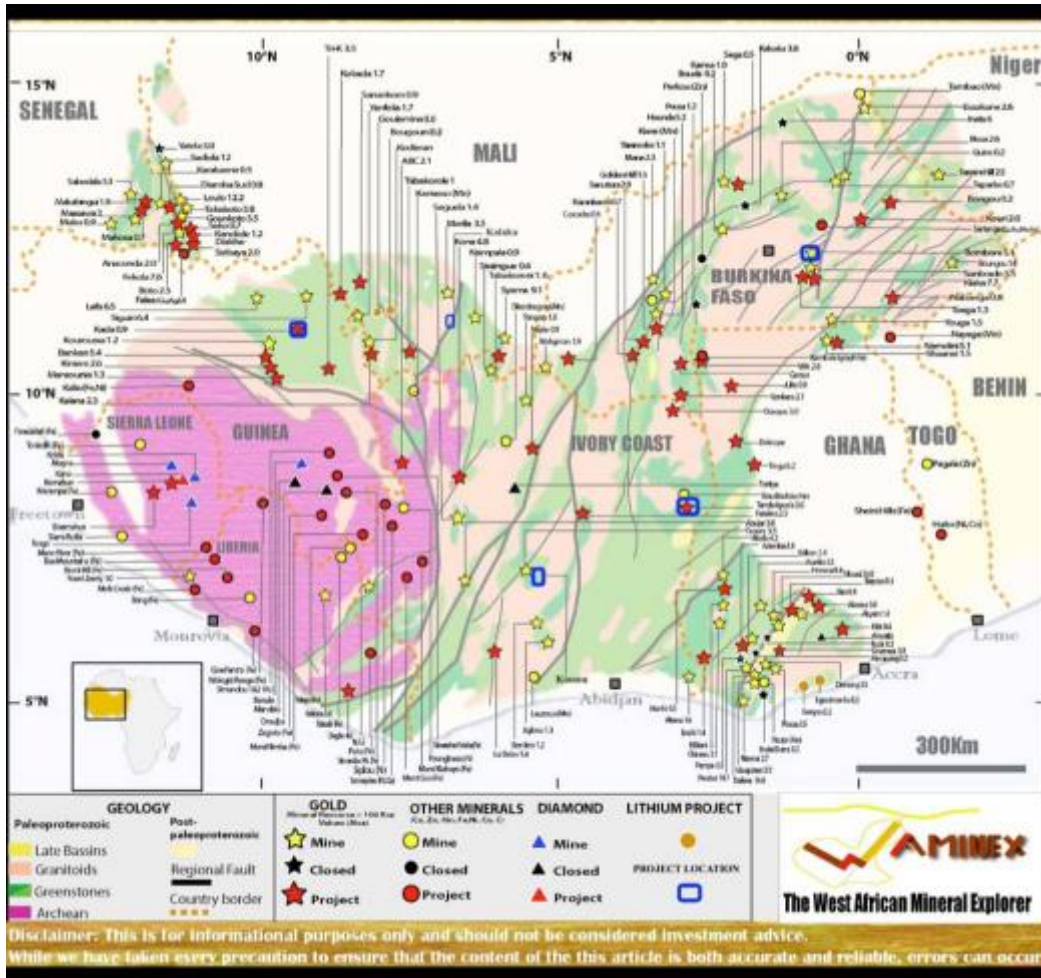


Figure 1 The geology map of the West African Craton

The literature describes 5 types of artisanal gold mining: traditional (mining is carried out by many generations and is inherited); seasonal (after completion of agricultural work as an additional source of income); constant coexistence in the territories of industrial mining of deposits; shock (in conditions of force majeure - drought, economic crisis, sharp rise in prices); migration (when new deposits are discovered within several months) [2].

As a rule, artisanal gold mining is carried out by the poorest, socially vulnerable sections of society who are trying to survive in conditions of a shortage of qualifications and lack of education. In developing and underdeveloped countries, non-industrial gold mining is the main source of income for many people. Gold mining provides gold miners and their families with a permanent or temporary income to survive in the absence of other work.

According to the International Labor Organization in 1999, there were 13 million artisanal and small-scale gold miners worldwide. Another 100 million people depend directly or indirectly on these activities for their survival.

The artisanal and small-scale gold mining sector accounts for approximately 25–30% of global gold production. Artisanal gold mining in African countries ranges from 2 to 14 tons per year [3].

The environmental cost or environmental footprint of this gold mining method is significant. The worst environmental impact of artisanal gold mining is mercury pollution. About a third of all mercury used in the world (that's 1,000 tons) from artisanal miners ends up in the environment. Artisanal and small-scale gold mining is officially recognized as the largest source of mercury pollution in the environment. These types of gold mining account for 38% of all mercury

emissions. For example, in 2018, mercury emissions amounted to 1,846,720 pounds or 839.4 tons and exceeded emissions of pollutants from coal combustion and non-ferrous metal production

Let's consider the most significant factors of the negative impact of artisanal gold mining on the environment and the health of workers

1.1. Mercury intoxication of ecosystems, gold miners and local populations

The issues of mercury pollution in artisanal gold mining receive significant attention. Thus, in 2002, the international project "Global Mercury Project" (GMP) was launched and the "United Nations Industrial Organization" (UNIDO) received funding from the "Global Environment Facility". Environment Facility - GEF) and the UN Development Programme - UNDP. A report was prepared and published presenting data on mercury emissions from artisanal gold mining sites in Brazil, Indonesia, Laos, Sudan, Tanzania and Zimbabwe. It was found that in 2009 in Brazil, Sousa and Veiga, for each of the 40 thousand miners working in the Crepori region (Tapajos basin), there was an average of 40 grams of mercury per month.

With mercury amalgamation, droplets of mercury fall into the water and evaporate into the atmosphere. If a retort or steam trap is not used when heating the amalgam, miners are directly exposed to mercury vapor, which immediately harms their health, especially the nervous system, and also contaminates the local food chain and ecosystem. Mercury consumption levels have been identified as hazardous in more than 24 countries.

Mercury vapor levels at amalgam burn sites can reach high levels and almost always exceed the WHO public exposure limit of 1.0 µg/m³. This concentration not only affects artisanal gold miners, but also communities in the immediate vicinity of processing centers. The evaporated mercury eventually ends up in the soil or settles to the bottom of lakes, rivers, bays and oceans and is converted by anaerobic organisms to methylmercury [4].

In water bodies, methylmercury is absorbed by phytoplankton, which is food for zooplankton and fish, resulting in contamination of the food chain. Accumulation occurs primarily in long-lived predatory species, including sharks and swordfish.

The review [5] provides data on the accumulation of mercury in the hair and biological fluids of miners and community residents near mining sites. Urine mercury levels have been found to be significantly greater than 50 µg mercury/g-creatinine (urine levels considered to be associated with renal tubular effects) and/or 100 µg mercury/g-creatinine (urine levels considered to have "high" likelihood of classic neurological signs of mercury poisoning). Those who simply live in artisanal gold mining areas, including children, have urinary mercury levels greater than 100 µg mercury/g-creatinine. People living downstream from gold mining sites had hair mercury levels more than 10 times higher than the hair mercury concentration (2.5 µg mercury/g) associated with the temporary tolerable weekly intake (TWA). This GLI for methylmercury was established by the Joint FAO/WHO Expert Committee on Food Additives (JECFA).

Mercury and methylmercury have been shown to be toxic and fatal to the central and peripheral nervous systems, digestive and immune systems, lungs and kidneys. Mercury intoxication causes mental retardation, seizures, loss of vision and hearing, developmental delays, speech impairment and memory loss. Chronic mercury exposure in children has been reported to result in what is known as acrodynia syndrome, which is characterized by redness and pain in the extremities.

When examining gold miners in Burkina Faso, symptoms of mercury intoxication were identified such as frequent headaches, sleep disturbances, unusual fatigue, trembling and visual disturbances, and kidney problems.

1.2. Deforestation, destruction of ecosystems

Rising gold prices and increased demand have led to approximately 6 thousand hectares of tropical forests in Peru disappearing every year [6]. In general, the rate of forest area reduction increased from 2 thousand hectares per year to 6 thousand. This has been proven by aerospace surveys and a map of the deforested area has been compiled.

Brazilian scientists have shown that deforestation in the Brazilian Amazon for gold mining led to the release of 96 million tons of carbon dioxide between 2013 and 2021, affecting the forest's function as a carbon sink in the region. However, CO₂ emissions in the last three years, from 2019 to 2021, amounted to 59%, indicating increased destruction. Deforestation in indigenous territory amounted to 1,708 square kilometers or 2.38 percent of total deforestation in the Brazilian Amazon during this period. Scientists analyzed 232 areas where indigenous people live and found that annual

deforestation averaged 35 square kilometers, increasing by 129% between 2013 and 2021. Over the last three years of the period, the growth was 195% [7].

2. Pollution of watercourses

A 2019 study found that water downstream from the Rio Tinto mining site in Madagascar contained high concentrations of uranium and lead that could harm local residents who rely on water from a nearby lake and river for drinking.

A 2019 report from Columbia University found elevated concentrations of heavy metals in rivers and streams near the Porgera mining site in Papua New Guinea. The mine site, operated as a joint venture between Barrick Gold Corp and Zijin, discharges tailings directly into rivers with government permission.

A Columbia study confirmed that levels of toxins such as cadmium, lead, nickel, arsenic and zinc exceed national and/or international drinking water standards. Although most residents do not use these springs for drinking water, children often play in the rivers and streams, and local residents report a burning sensation on their skin after coming into contact with the tails. According to the report, Barrick Gold Corp acknowledged that the tailings pose a risk to those exposed to the waste.

In 2021, the provincial court in British Columbia in Canada fined Teck Coal (a subsidiary of Teck) approximately \$47 million for selenium and calcite contamination of water bodies in the Elk Valley. This is the largest fine for offenses under Canada's Federal Fisheries Act to date. However, environmental groups say the fine is an insufficient deterrent given that it is disproportionate to the company's revenues, so they have expressed alarm that the fine only relates to pollution in 2012, with the Crown Prosecution Service agreeing not to bring charges related to the emissions. same pollutants for the period from 2013 to 2019. [8].

Heavy metals pose a particular danger to the hydro- and lithosphere, as they migrate, disperse and accumulate in plants and animals, and then can be transmitted through the food chain to people as the final consumer. Heavy metals cause "oxidative coma" in plants, affecting photosynthesis, chlorophyll fluorescence and stomatal resistance. For example, copper interferes with photosynthesis and reproductive processes; lead reduces the production of chlorophyll, and arsenic interferes with metabolic processes. Consequently, plant reproduction decreases or becomes completely impossible [9-12].

3. Industrial injuries and occupational diseases of gold miners

In artisanal gold mining processes, working conditions are harmful and dangerous and cause accidents. When analyzing accidents in gold mining, it was found that more than 500 deaths were recorded as a result of safety incidents during the period from 2019 to 2020.

Most of the incidents were reported from external sources because the companies assessed did not provide sufficient data on these incidents in their reports. In 2019, a miner at Anglo American's Moranbah North mine in Queensland, Australia, was killed when he was hit by an out-of-control engineering vehicle. Three miners working underground at the Mopani mining site in Zambia died in 2019 when a car caught fire while refueling. A month later, two workers were killed in an explosion at the same mine, which was then jointly owned by Glencore, First Quantum Minerals and a Zambian investment firm.

During artisanal gold mining, the miner is affected by complex exogenous factors: 1) climatic and meteorological; 2) microbiota, whose biological properties are changed by the technological process or its consequences; 3) unfavorable conditions in the work area (constant dampness, dirt, toxic fumes, gases, dust and suspended matter, noise, vibration, irregular, monotonous diet, stress, etc.), 4) mineral and organic dust containing heavy metals and having toxigenic, fibrogenic, mutagenic, carcinogenic and allergenic properties.

Industrial dust mixes with dust entering the environment during soil erosion, forest fires, with pollen from trees and grasses, spores of fungi and bacteria, which increases both the nature of harmful agents and their quantity. Thus, an extreme environment, having a complex and long-term effect on gold miners, can disrupt mutually beneficial relationships and connections between the body and its microbiota (the totality of all microorganisms inhabiting the open cavities of the human body) [13,14].

Health problems for gold miners who worked underground include decreased life expectancy; increased incidence of cancer of the trachea, bronchi, lungs, stomach and liver; increased incidence of pulmonary tuberculosis (PTB), silicosis and pleural diseases; increased incidence of insect-borne diseases such as malaria and dengue fever; noise-induced hearing loss; increased prevalence of certain bacterial and viral diseases; and diseases of the blood, skin and musculoskeletal system. These problems have been documented among gold miners in Australia, North America, South America and Africa. In general, HIV infection or excessive use of alcohol and tobacco tend to worsen existing health problems [15].

A case study was carried out in Ghana with 494 small-scale gold miners from four major mining regions in Ghana. A household-based approach was used to obtain a representative sample of miners. The study was conducted from June 2015 to August 2016. A systematic sampling technique was used to select households and recruit respondents for interviews. Miners were asked about any mining-related injuries.

It was found that the annual injury rate in gold mining was 289 cases per 1000 workers. Injuries were primarily caused by machinery/tools 66 (46.1%) followed by slips/falls 46 (32.2%). The main risk factor for injury was underground work (adjusted odds ratio for injury, 3.19; 95% CI = 1.42–7.20) compared with above-ground work. Levels of college education were protective, with adjusted odds ratios of 0.48 (95% CI = 0.24–0.99) for high school education and 0.38 (95% CI = 0.17–0.83) for high school education by compared to no training. Only 15 (3.0%) miners reported receiving safety training in the past year, and 105 (21.3%) indicated that their workplace had safety regulations. A small number of workers reported using work boots 178 (36.0%) and gloves 134 (27.1%), but less than 10% of workers used other personal protective equipment.

Researchers have found that annual injury rates among small-scale gold miners are high. To improve safety, it is necessary to pay significant attention to training in safety issues and the provision of personal protective equipment [16-18].

4. Crime and social instability

The situation in Colombia is widely known, where artisanal small-scale gold mining has been taken over by local military and criminal groups who have switched to it from the drug business. An example of social instability is the current situation in Ghana, whose deposits have been overrun by illegal Chinese gold miners, which has caused an explosion of discontent on the part of the local population, which has begun to carry out armed attacks on Asian miners.

African governments are concerned about crime in this business. In Guinea, for example, the government is making it a priority to bring miners into a more legal and formal structure, creating a real climate of cooperation and trust. To achieve these goals, Guinea has adopted new legislation and regulations that are more enabling and encouraging, as well as better institutional practices to provide oversight and assistance to mining groups. The long-term goal is to ensure a gradual transition from craftsmanship to a small formal mine.

The Government of Guinea took a major step today by launching a US\$17 million project to reduce the use of mercury by the nation's gold miners. The artisanal and small-scale gold mining (ASGM) sector in Guinea is valued at \$300 million. The main focus today is on reducing mercury consumption in gold mining.

Led by the United Nations Environment Program (UNEP), with financial support from the Global Environment Facility (GEF) and support from the African Center for Environment and the Environment (CASE), a project is being implemented in Guinea - part of the planetGOLD program - aimed at reducing the use of mercury in Guinea's mining sector is funding and implementing mercury-free technologies.

Guinea will join twenty-three countries taking coordinated action around the world under a GEF-funded program [19].

The planetGOLD program prioritizes the application of human rights principles to development work and focuses on those who are most marginalized, excluded or discriminated against. In the context of ASGM, adopting this approach focuses attention on the rights and responsibilities of both ASGM participants and the government. This means that the rights of individuals working throughout the ASGM supply chain are respected, protected and fulfilled, and that governments and other organizations are held accountable and supported in fulfilling their responsibilities to respect and protect those rights.

5. Conclusion

In conclusion, it should be noted that we have considered the most significant safety problems, especially from the point of view of the impact of environmental factors on the environment and human health. The arrival of investors and the transition to industrial gold mining technologies will reduce the negative impact and make the work of mining workers easier.

Compliance with ethical standards

Acknowledgement

We would like to thank the Russian government for its unwavering support for the quality of the training, and the Guinean authorities for their willingness to support the project.

Disclosure of conflict of interest

The authors agree that this article may be published in this journal.

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