



**UNIDO**  
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Report

**Artisanal Gold Mining Activities in Guyana**

prepared by

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## Summary

*This report comprises a preliminary assessment of the artisanal gold mining activities in Guyana as a result of a five-day visit to the Mahdia Project.*

*Differently from other countries in South America, the artisanal mining sector in Guyana seems to have more control by the Government. The presence of the Guyana Geology and Mines Commission (GGMC) in the interior is a relevant factor for a relative control, assistance and enforcement.*

*Number of artisanal miners in Guyana ranges from 6,000 to 10,000 and the annual gold production by “porknockers” might be around 3 or 4 tonnes. According to GGMC all porknockers are working in legal claims.*

*The Mahdia project is an initiative of the GGMC to bring technology to miners. The project will reinforce the presence of the Government in the interior bringing infrastructure and assistance for porknockers. The GGMC is very receptive and flexible to expand the project objectives to accommodate ideas such as Amalgamation Centers or Experimental Mining Centers. GGMC has optimal conditions to receive UNIDO support in the Mahdia project. The technical team is composed by an enthusiastic group of young engineers and geologists who, with little training, can transform Mahdia Project in an example for other countries. GGMC, with 250 employees, seems to be an organized institution with a relative financial support from the Government. The main technical assistance needed for the Mahdia seems to be related to environmental project management, environmental monitoring (analytical facilities), adequate mineral processing technologies, tailing disposal and revegetation, environmental education and ecotoxicology. Guyana also has experienced professionals who have lent their expertise to the project.*

## An Outline of the Gold Production in Guyana

Guyana has an area of 214,969 km<sup>2</sup> and a population of 750,000 that consists of 50% Indo-Guyanese, 36% Afro-Guyanese, 7% Amerindian and 7% of other origin. Over 90% of the population lives on the coastal area (Fig. 1). The proportion of the population living in poverty is around 45% and this has increased. Guyana has the lowest GDP per capita in Latin America, US\$ 330.

Gold production in Guyana was first officially recorded in 1884. For many decades, artisanal miners have been operating generally as individual or small family concerns. The artisanal activities were intensified in the last decade with introduction of other mining methods than the manual panning. Guyanese miners use to copy mining methods from Brazilian “garimpeiros”. About 400 dredges are in operation in the country in the Essequibo River and its tributaries, the Mazaruni River and its tributaries, the Cuyuni, Puruni, Semang, Eping, Kurupung and Meamu Rivers, the Potaro River and its tributaries, the Kuribrong River and in the Konawaruk River.

Most dredges have a cutter-head system that hits a hard layer of sediment (crust of cemented gravel in a sandy matrix of ferruginous material) in which the gold is immediately below. This system is called “missile”. Based on a wrong perception caused by the name, many people believe this mining method uses powerful explosives. Small pits of alluvial colluvial and elluvial deposits on lands adjacent to the rivers are also fairly widely mined in Guyana. Nowadays, there are 1,000 small-scale (artisanal) mining permits issued by the Guyana Geology and Mines Commission (GGMC). The number of miners increased drastically from 6,000 in 1992 to 10,000 in 1997 according to estimate of Mr. Woolford (Deputy Commissioner) and Mr. Brian Sucre (Commissioner) from GGMC. No register of small miners is still available in Guyana. Between 300 to 500 Brazilian “garimpeiros” are currently working in Guyana. GGMC believes that there is no artisanal miner working in illegal areas, such as companies’ claims.

Gold production from artisanal miners was 2.8 tonnes (90,000 oz) in 1994, 3.1 tonnes (99,000 tonnes) in 1995 and 3.4 tonnes (110,000 oz) in 1996<sup>1</sup>.

Artisanal mining activities for gold and diamonds are not producing a high level of income for the participants but it is a significant source of employment in Guyana<sup>2</sup>.

The only gold producing company in the country is the Omai Gold Mines which reported in 1996 an output of 8 tonnes (257,000 oz) from its cyanidation plant. Omai is the single largest foreign investor in Guyana. The company is 60% owned by Canada-based company Cambior Inc., 35% by Denver-based Goldstar Resources and 5% by the Guyanese government. The US\$ 250 million gold plant started in 1993 increasing the Guyanese gold output from 2.8 tonnes (90,000 oz), produced exclusively by small miners, to 9.6 tonnes (309,100 oz).

The Guyana Geology and Mines Commission (GGMC) is the institution in charge of providing reconnaissance, exploration and mining licenses as well as of establishing regulatory provisions for

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<sup>1</sup> Veiga, M.M. (1997). Introducing new technologies for abatement of global mercury pollution in Latin America. Book edited by UNIDO/UBC/CETEM. Rio de Janeiro, 94p. ISBN: 85-7227-100-7.

<sup>2</sup> Jones, R.C. (1997). Amelioration of the Impact of Small-scale Mining on the Environment in Guyana. Proposal from GGMC to British Geological Survey. 3p.

the mineral sector in Guyana. It is also the organism responsible for the geological service, such as mapping, geochemical analysis, prospecting guidelines, etc. The GGMC is directly administered by the Republic President and it is self-supported by 5% of royalties received from all producing mines. Part of this income stays in GGMC and the rest goes to the Presidency. With 250 people, GGMC has an annual budget around US\$ 1 million.

In Guyana, an individual gold producer pays 2% of tax + 5% of royalties to GGMC. There is no further income tax for miners<sup>3</sup>. All mining companies in Guyana pay 35% of income tax. Naturally, companies can deduct their expenses while individuals cannot. So, after such a size of mining operation it is convenient for an individual to become a company.

With the growing worldwide concern for the environment in recent years, the government of Guyana<sup>4</sup> has placed a high priority on environmental issues. Although dredge mining operations are generally being conducted on a small scale and in remote areas, GGMC recognized the need to minimize the adverse effect of the current mining activities

## **Mahdia Project**

The mining area of Proto-Mahdia is located 200 km southwest of Georgetown, latitude 5° N and longitude 58°W (Fig. 1). The area has been extensively mined for many decades and a poor mining village with about 6000 people is established. Villagers are facing economic and health problems as gold price is low and malaria is rampant in the region. In the past, a mining company conducted a reconnaissance program in Mahdia and did not find attractive gold potential to invest in a further mining project. The area was returned to GGMC that took the opportunity to establish an experimental project for artisanal miners.

GGMC established reserves of 13 million m<sup>3</sup> with an average grade of 0.46 g/m<sup>3</sup>, resulting in almost 6.0 tonnes of gold (193,000 oz) in the alluvial-colluvial ore.

The project area was divided in 34 mining blocks of 20 ha/each where 3 main pits have been mined for more than 50 years (Fig. 2):

- St. Elisabeth
- White Hole
- Red Hole

St. Elisabeth and White Hole are both mining areas with 300,000 m<sup>2</sup>/ea and innumerable pits where miners extract gold from alluvial material with predominance of white sand and silt. Red hole is an area with 200,000 m<sup>2</sup> and seems to be a lateritic alluvial material with higher grade of gold than White Hole and St. Elisabeth. Miners use hydraulic monitors associated with rudimentary wooden sluice boxes. Angular quartz fragments are rejected, as there is no milling facility on the site.

Miners excavate the alluvial deposits by using hydraulic monitors. The alluvial covering is as thick as 100 m and the misuse of the mining method is silting watercourses across lowlands eventually

<sup>3</sup> This is an incentive for artisanal miners as individuals in other economic activities must pay 33% of income tax. The Government is thinking in introducing different levels of income tax for individuals, but currently everyone pays 33%.

<sup>4</sup> Watkin, E.M. and Woolford, W.H., 1992. Alluvial Gold Mining in Guyana - Environmental Aspects. Report of Guyana Geology and Mines Commission.

reaching the Mahdia River. Many creeks were diverted to provide water to the monitors. Tailings are dispersed on the surface and sometimes to an excavated pool where some water reclamation occurs.

The hydraulic monitor using pumps of 4, 6 inches and sometimes 10 inches is the main mining method used in Mahdia (Fig. 3 to 8). The operation is frequently associated with riffled (or not) sluice boxes lined with carpet. Once a week, the operation stops and the gravity concentrate is amalgamated (see next section for details).

The gold grade of colluvial and alluvial terraces is variable. In an interview with a Brazilian “garimpeiro” working in Mahdia, he showed his production of 10 days of work, mining about 1200 m<sup>3</sup>. He extracted 124g of gold (4 oz) that results in a grade of 0.1 g/m<sup>3</sup> of gold in the surface material. His production is split with the landowner (10%) and 27% for the 5 workers. On top of this, he pays 2% of tax and 5% of royalty for GGMC. In Saint Elisabeth another miner declared that he extracts 310 g (10 oz) of gold/week. Reprocessing tailings, additional 90 g (3 oz) of gold are obtained.

Mahdia project was conceived to increase the presence of GGMC in the interior of the country as well as to demonstrate mining and mineral processing techniques to porknockers. Since 1991, GGMC has been dedicated to study the social and economic aspects of the Mahdia’s miners. In 1997, Mr. Woolford, the project coordinator, established the objectives of the project and initiated a series of studies for land reclamation, construction of adequate tailing ponds, technology transfer for miners, etc. Professionals from GGMC went to Zimbabwe to visit the Shamva Mining Center established in 1989. The mining scale and methods of Shamva are fundamentally different from the semi-mechanized operations in Mahdia but the example of cooperative work and organization are worth to be copied.

Miners interested in having a mining block in Mahdia must sign an agreement with GGMC called “mining permission”. The permission holder shall inform the Commission the number and names of people working in the area. A permanent inspection of the area, books and records is enforced by the Commission in order to have tight control of the gold destination. GGMC has an office in the Mahdia village and all gold leaving the mine site requires a written permission. In the future, miners will pay 3% of the gross gold production + royalty to support the infrastructure and technical assistance that will be provided by GGMC for the leaseholder.

Miners must also sign an Environmental Management Agreement with the Commission to ensure that the environmental impacts will be minimized. This agreement establishes provisions for the following activities and unit operations:

- exploration disturbance
- mining excavation
- deforestation
- clearing rivers and creeks
- removal of topsoil
- sediment loading
- settling ponds
- handling of mercury
- burning of amalgam

- use of petroleum products and other poisonous substances
- environmentally damaged areas

Miners are responsible for all damages to the environment. In order to assure this responsibility, miners must lodge a bond in the form of a Bank Guaranteed deposit in favor of the GGMC, for an amount determined by the Commissioner. The bond can be used by the Commissioner to restore the environment. If the miners restore the area, the Commissioner refunds the bond and the interests. This type of enforcement mechanism can be dangerous as many miners can think that the deposit is enough to restore all degraded areas, which is usually not true. As long as further penalties are also applied to those impacting the environment, the environmental bond can be a useful way to select the type of miner that may hold a mining permission.

Most items in this agreement are simple and straightforward. An example is when a miner is silting up waterstreams. If the contaminant is released in a watercourse near a settlement or a village, the concession holder is under obligation to notify the affected people and provide an alternative source of water for drinking and domestic use. This alternative source must not be a half of mile distant from the affected people dwelling.

According to this agreement, miners are allowed to use mercury. The only provision for mercury handling is the obligatory utilization of gloves. This is adequate but too simplistic as the main occupational exposure pathway for operators is not through skin absorption but by inhalation of mercury vapors. The mandatory use of retorts is a competent measure. Other provisions related to amalgamation of whole ore or dumping contaminated tailings in the waterstreams should be included to avoid dispersion of mercury droplets with the tailings and/or creation of hot spots of mercury in the environment. An efficient measure is to prohibit all operations that use mercury to amalgamate the whole ore, such as copper-mercury plates, mercury in sluice boxes, etc. In these cases, the equipment must be seized and the leaseholders must have their permission cancelled. As indicated by GGMC, most miners use mercury to amalgamate only the gravity concentrates. In this case, provisions must be established to keep the amalgamation tailings separately in drums or lined pools. In the future, this tailing can be used to extract residual gold and consequently mercury.

Mahdia Project has some support from the Guyana Gold & Diamond Miners Association which has 70 active members representing the major artisanal miners, those with large operations. The majority of the project funds of US\$ 1 million in 5 years comes from GGMC. Half of the budget is to be spent on infrastructure and 36% is operating cost.

## **Mercury in Mining Operations in Guyana**

Guyana's new Mining Act came into force in July 1991. While no general or specific provision is made for prevention of pollution or protection of the environment, the broad general framework providing for the granting of mining permits and claim licenses would enable inclusion of environmental protection provisions as conditions to obtain such permits. In addition GGMC is empowered to give directions to miners on matters of safety and good mining practice and they are obligated to comply promptly with such directions.

Mercury is used in Guyana gold mining operations to extract gold from the final concentrate produced in the gravity separation process. Mercury is added to a bucket containing the final

concentrate and water. Amalgamation occurs as the gold and mercury are brought into contact by hand mixing the contents of the bucket. Approximately 14 grams of mercury are required to amalgamate 1 kg of concentrate (ratio Hg:conc.=1:70). The resulting amalgam is squeezed through a fine cloth to remove the excess mercury which is re-bottled and used again. The gold-mercury amalgam is then heated in a tin over a fire or blowtorch until the mercury vaporizes. Occupational exposure is obviously a very serious concern.

Gold is sold to official dealers designated by the Guyana Gold Board, located in the GGMC. The GGMC also buys gold from miners. The price of gold paid by GGMC is 90.4% of the price of pure gold established by the international market. In 1996 they melted 3.1 tonnes (100,000 oz) in their premises in Georgetown. GGMC has a small lab where gold is initially burned (but not melted) to eliminate part of the mercury from the gold sponge brought by the miners. The sponge is weighted to calculate the value to be paid. Later on, gold is melted and converted to bars. So far, Guyana has no facilities to refine gold. The GGMC operators use mercury masks (Fig. 9) while burning and melting gold. They have frequent urine analysis, but they do not have access to the results; they are just informed by the manager that “the mercury levels are noticeable but low”. The vapor flows through fume hoods to a scrubber (Fig. 10) using water for mercury abatement. No mercury monitoring in the surroundings is available.

Improvement in the mercury abatement process is not very complicated as activated-charcoal filters impregnated with iodine solution can be installed. As well, the use of iodine solution in the scrubbing process can improve significantly the mercury precipitation.

The GGMC considers unlikely the possibility of serious environmental contamination of the rivers because of the type, size and distribution of the gold mining in Guyana. According to GGMC, contamination, if it is occurring, is most likely localized.

The government recognizes that the artisanal miners cannot afford sophisticated environmental impact assessment reports or advanced mineral processing equipment. As gold purchase is strictly controlled by the Government, this is an excellent opportunity to show the miners how to use retorts. When a miner was selling gold in GGMC, I had chance to make a simple sketch to tell him how to make his own retort with plumbing pipes and connections. The miners stated that he has never found a retort in Georgetown market.

In hydraulic mining operations, amalgamation is conducted by spreading and rubbing 30g of mercury on the heavy concentrate retained on sluices. This inefficient amalgamation process is conducted to avoid further panning operation to separate amalgam from heavy minerals. Mercury is clearly lost to the environment in this operation. Analyzing the physico-chemical conditions of the water in the tailing ponds, it was possible to infer that reaction of mercury with organics is a possible mechanism to mobilize the pollutant into solution and consequently into the food web. The main reason by which miners use this unique amalgamation method is to obtain amalgam as fast as possible for safety reasons. Using the same argument, miners justified why retorts are not used.

## **Conclusion**

Mahdia Project is an excellent initiative of GGMC to implement an experimental training program for artisanal miners. This project fits into the UNIDO concept of bringing more technology and



education for miners through programs such as Experimental Mining Centers or Amalgamation Centers. GGMC seems to be flexible and receptive to incorporate ideas into the project to provide miners with training in mining and mineral processing techniques enhancing their technical and economic skills. Mahdia can be used as a training unit to transfer knowledge to miners working under realistic conditions at the mine sites. While producing gold, miners can be exposed to concepts of geological exploration, ore reserve estimation, mining and concentration techniques, environmental impact, occupational hygiene, water reclamation, tailing pond building, revegetation, bookkeeping, etc. In addition, the project can provide the miners and their families with advice on how to obtain financial support, how to plan a mining operation, how to avoid mercury exposure and ingestion of contaminated fish, how to start alternative economic activities and other family matters. It is also important to integrate all key components of the Mahdia community in this project.

It is clear that the GGMC has human resources to conduct the project but little training would be important for the young team of geologists and engineers. Most of the funds needed to establish the basic infrastructure conditions for the project are being funded by GGMC, but further funds are needed to improve technical assistance and to keep the project running for at least 5 years.

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1977	Received degree in Metallurgical Engineering from the Catholic University of Rio de Janeiro, Brazil.
1978	Started M.Sc. program on Environmental Geochemistry at the Federal Fluminense University - UFF, Rio de Janeiro, Brazil
1979	Hired by the Center of Mineral Technology – CETEM, Rio de Janeiro, a National Research Center. Head of the Instrumental Analysis Lab providing analytical support to ore processing and hydrometallurgy projects. From March 79 to December 83, lecturer of Mineralogy & Petrography at the Dept. of Metallurgy and Materials Science. Catholic University - PUC/Rio de Janeiro.
1984	Received the M.Sc. degree in Environmental Geochemistry from UFF. Thesis: Geochemical properties of the copper-hydrous ferric oxides binding, Salobo, Carajas. Invited to participate in the research group of Dr. W.S. Fyfe as a visiting researcher at the University of Western Ontario, Dept. Geology. Hired by Doce Geologia e Mineração S.A., a subsidiary of Companhia Vale do Rio Doce, as a technical assistant of the director of Geology. Rio de Janeiro.
1986	Moved to São Paulo to work as the R&D manager of Paulo Abib Engenharia S.A., an engineering company leader in mining projects in Brazil.
1989	Worked for 6 months as a consultant to the Pocone Project set up by CETEM to investigate the effects of Hg discharged by gold mining operations in the Ecological Park of Pantanal, Western Brazil.
1990	Worked as consultant for Enerconsult Engenharia S.A. an engineering company in São Paulo involved with two gold projects (exploration, mine and beneficiation plant design) for clients in British Columbia. Started the doctoral program at the Dept. of Mineralogy and Petrology of University of São Paulo.
1992	Joined the Department of Mining and Mineral Process Engineering of the University of British Columbia, Vancouver as a visiting researcher to apply Artificial Intelligence tools to Environmental Sciences. Transferred to DMMPE-UBC as a PhD candidate.
1994	Received his PhD from DMMPE-UBC. Thesis: "A Heuristic System for Environmental Risk Assessment of Mercury from Gold Mining Operations".
1995	Moved back to Brazil. Director of Madison do Brasil S.A. (a Canadian Mining Company) in Rio de Janeiro also consultant for UNIDO - United Nations Industrial Development Organization - alternative gold mining techniques and mercury remediation for the artisanal goldfields in Venezuela (Puerto Ordaz, 3 months).
1996	Moved back to Vancouver. Adjunct professor of the DMMPE-UBC. Lecturer of Artificial Intelligence Applications to Mining Engineering. Consultant for UNIDO (Vienna) on issues related to mercury pollution in Latin America as well working as a consultant for Canadian mining companies.
1997	Appointed as assistant professor of the DMMPE-UBC. Consultant for UNIDO for artisanal gold mining activities and mercury emissions in Suriname and Guyana.
1998	Assistant professor of the DMMPE-UBC. Main instructor of the courses Mining & Environment and Process Mineralogy. Consultant of the Sivam Project on issues related to mercury pollution in the Amazon region. Since 1989, 1 book and 33 international publications just on issues related to mercury pollution.

***Figures***

Fig. 1 – Towns and Major Settlements in Guyana

Fig. 2 – Mining Blocks of the Mahdia Project