



**UNIDO**  
United Nations Industrial Development Organization

Report

**Artisanal Gold Mining Activities in Suriname**

prepared by

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## Summary

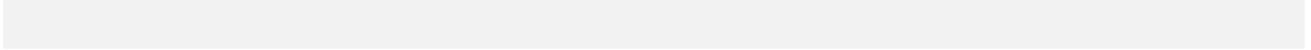
*This report comprises an initial assessment of the artisanal gold mining activities in Suriname to serve as a basic document to formulate a technical cooperation program between Suriname government and UNIDO. The artisanal mining sector in Suriname seems to be out of control, as the Government has weak presence in the interior of the country. The invasion of Brazilian “garimpeiros” is rampant and somehow welcomed by the local miners in the interior who have learned semi-mechanized mining techniques. The concept of panning for subsistence, alive in the Maroons for almost a century, has been replaced with the practice of large and profitable mining operations. This would be very beneficial for the people in the interior if carried out in an organized fashion. But the Brazilian “invasion” is also degrading moral, social and environmental standards. At this point, there is no apparent conflict between Brazilians and Surinamese miners, but between Brazilians and bandit groups.*

*Number of artisanal miners in Suriname ranges from 8,000 to 15,000. This latter number seems to be more accurate since there are 8,000 Brazilian “garimpeiros” already registered in the Ministry of Labor. Annual gold production in Suriname might range from 8 to 12 tonnes.*

*The environmental impacts caused by miners are localized at some areas of the greenstone belt in the southeast of Suriname. Most mining pits are still shallow but the lack of adequate mining techniques is causing noticeable damages to the watercourses. Villagers are facing siltation problems and losing their sources of drinking water. Malaria, leishmaniasis and prostitution are spreading rapidly in the interior. Local miners are adopting the same gypsy characteristics of the Brazilian “garimpeiros” and going after profitable goldfields elsewhere. Families are being destroyed. Young natives are no longer interested in farming and agriculture. Mining became an economic alternative for the people in the interior who are completely marginalized from the rest of the country. The high grade of gold in the alluvial, colluvial and eluvial ores in Suriname indicates that the gold rush is just beginning and more people from Paramaribo and foreigners will be soon involved in this activity. Mercury has been extensively used by artisanal miners, including women and children. The lack of knowledge about the danger of mercury vapors is exposing innocent people to high doses of this pollutant. Mercury is freely sold in Suriname and most miners, by ignorance, use excess mercury to amalgamate the whole ore. The effect of methylmercury bioaccumulation in fish is still unknown but definitely high values must be found in some mining zones. The effect of hydroelectric impoundment in increasing mercury concentration in carnivorous fish was not yet evaluated in Suriname.*

*A project proposal to establish a Foundation for Experimental Mining is attached to this report. This idea has been an aspiration of the Surinamese Geological Mining Service to re-establish its presence in the interior as well as to bring discipline and provide artisanal miners with techniques to reduce environmental impacts. The Foundation has been conceived to create various Experimental Mining Centers in specific mining concessions in which miners may learn simple procedures of geological exploration, mining and mineral processing while producing gold. The concept is similar to the UNECA Centers promoted by UNIDO but goes beyond the amalgamation and decontamination services and reinforces the educational role of the original proposal. Through the Foundation, artisanal miners and communities can also receive support and advice on issues related to legalization of mining activities, creation of social benefits and funds, organization of miners, occupational health, safety, family matters, bookkeeping and reduction of environmental impacts.*

*The implementation of this or any project related to mining in Suriname must have as a prerequisite the establishment of the Minerals Institute or other type of authority that brings organization to the sector in the Government domain.*



## **An Outline of the Surinamese Mineral Sector**

Suriname has an area of 163,265 km<sup>2</sup> and the smallest population of any country in South America - fewer than 450,000 people. Nearly all inhabitants of Suriname live within a 30 km wide coastal region. The capital Paramaribo has approximately 40% of the Surinamese population.

The mining sector accounts for 4% of the GDP in which bauxite and gold are the main mineral resources. A small production of petroleum (1,000 tonnes/day) is conducted by the state oil company Staatsolie Maatschappij Suriname N.V. from the Tabaredjo field, west of Paramaribo. With an annual production of the order of 4.0 Mtonnes, Suriname ranks amongst the top ten bauxite sources in the world. The country also produces alumina (1.6 Mtonne/y) and aluminum (32,000 tonne/y). There are two large operators, Suriname Aluminum Co. (SURALCO), a subsidiary of the Aluminum Company of America (ALCOA) and Billiton Maatschappij Suriname N.V.

All known gold deposits in Suriname are located in the Guiana Shield which is an extensive Precambrian greestone belt that encompass 415,000 km<sup>2</sup> extending from Venezuela through Guyana, Suriname, French Guiana into Brazil's Amazon basin. Suriname's portion of the Shield consists of two high-grade metamorphic zones in the western part of the country, and a semi-circular low-grade metamorphic zones stretching from the southeast to the northwest. A vast area of granitoid and metavolcanic rocks separates the high-grade and the low-grade metamorphic zones.

The majority of gold is exploited by artisanal miners. Currently the only company producing gold in Suriname is Sarakreek Resource Corporation which is a joint venture established in 1992 between the Canadian company Canarc Resources and a local company, Wylap Developments, which is the mine operator. Sara creek is a historical gold mining site with production of 16 tonnes of gold at the beginning of this century. In the 22,500 ha of the Sara creek concession, Canarc acquired the rights of 50% of gold production from alluvial terraces up to 5 meters and 80% of the sub-surface rights. Canarc Resources also holds an 80% interest option on the 138,000 ha Benzdorp concession, located in the southeast along the border with French Guiana. This area has been actively worked since the 19<sup>th</sup> Century and estimates of the cumulative amount of alluvial gold extracted in the past 100 years range up to 45 tonnes<sup>1</sup>.

Another company listed in Toronto Stock Exchange, Golden Star Resources, has been very active in this country since 1991. The approval on March 1, 1994 of the Gross-Rosebel Mineral Agreement by the National Assembly of Suriname marked a significant step for a large mining project in the Nieuw Koffiekamp area. The company is facing difficulties to deal with local communities. The Gross-Rosebel project, currently conducted in joint venture with other Canadian company, Cambior, has established a mineable gold reserve in excess of 43.5 tonnes (1.4 million oz) and growing. Golden Star holds exploration rights in Suriname over 485,000 ha of very prospective ground.

The potential for chromium, copper, iron, manganese, dimension stones, diamond and platinum has been indicated by many reports produced by the Geological Mining Service (GMD).

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<sup>1</sup> Anonymous (1996). Suriname, Diversified Mineral Prospects Attract Investors. Advertisement Supplement to Mining Journal, v. 327, n. 8402, 12p. London, Nov. 1, 1996

The current Surinamese mining law allows for 4 types of mining titles to be issued to qualified person or companies. These rights generally cover diamonds, gold and other minerals for both the surface and underground deposits in one permit:

- *reconnaissance rights* for up to 2,000 km<sup>2</sup> (200,000 ha) and for a maximum of 3 years (2 initial years with possibility of renewal for an additional year).
- *exploration rights* for up to 400 km<sup>2</sup> (40,000 ha) and a maximum of 7 years (initially for 3 years and with two renewals of two years each; at each renewal 25% of the area has to be relinquished).
- *exploitation rights* for up to 100 km<sup>2</sup> (10,000 ha) and for 25 years, which may be extended.
- *small mining rights* for alluvial and shallow working.

In the 1994 Mineral Agreement, at the time of the Gross Rosebel property negotiations, the government adopted specific fiscal provisions. These provisions brought fiscal stability, free convertibility of currency, US dollar-based accounting, automatic advancement of mineral rights from reconnaissance to exploration and exploitation, international arbitration for contracts and free export of gold production. A negotiable royalty of 3% is due when gold is sold.

A concept for a new mining code has been suggested by an agreement between Geological Mining Service and British Geological Survey to introduce fiscal and legal aspects to the Surinamese mining law.

## Gold Production and Artisanal Mining in Suriname

### *A Brief History of Gold Production*

Gold deposits in Suriname are known 400 years ago but the first initiative to explore gold occurred in 1870 when the first gold concession was granted to New York South America Suriname Goldmining Co. in the Sara creek region.

From 1873 to 1882 prospecting and exploitation of gold deposits were strongly stimulated to provide alternative employment for the workers coming from the plantation, after the end of the State control. In 1876, the first official production accounted for 38 kg of gold. In 1879, gold production reached 475 kg.

In 1894, a tax of 7 cents per gram of gold produced was introduced. This led to increase the number of police stations in the interior. At least 10% of the production was not reported. In 1896, the company “Goldfields of Suriname” started employing hydraulic monitors in Brownsberg region. The gold industry in Suriname has employed over 5500 people in 1901. A railroad built in 1903 to link Paramaribo (capital) to the goldfields brought tremendous development and Suriname reached a production peak of 1209 kg of gold in 1908<sup>2</sup>.

In 1943, the Geological Mining Service (GMD) was created to assist miners and improve geological exploration in the country. With the low price of gold established by the Breton-Woods agreement (1944) the mining activities were drastically reduced. In 1970, only a few tens of kilograms were produced in Suriname. As the price of gold gradually rose during the 70s, international companies were attracted to Suriname. The Canadian company, Placer-Dome established a large-scale project

<sup>2</sup> Anonymous (1997). De Gouden Draad. Suralco Magazine, v.9, n.3, p. 1-26.

together with the Surinamese government in the Gross-Rosebel area. The project did not continue and in 1986, due to internal conflicts, all gold exploration programs were deactivated.

### ***A Modern History of Gold Rush***

The artisanal gold mining activities in the interior of Suriname has been historically observed. It has been indicated<sup>3</sup> that mining is part of the economic tradition of the Maroons<sup>4</sup> ancestors in Africa. Since the 50s, Surinamese Maroons have been very active in prospecting gold in the interior. In the past, this was a sort of emergency resource since agriculture was the main living activity, but nowadays, gold mining represents a regular source of income for thousands of Maroons. As the result of the conflict, which started in mid-1986, the southeast region was almost completely isolated from the rest of the country. Food and other supplies were imported from French Guiana and priced in French francs. The inflation sky-rocketed in the interior. So, gold became a common currency in the interior. Gold was also used to support the activities of the Jungle Commando and other illegal armed groups. During 6 years of conflict, with no access to schools, many young Maroons learned how to mine for gold. Mr. Healy, from OAS (Organization of American States) disagrees with the comment that the increased involvement of Maroons in gold mining is attributed to a “gold fever”. He believes that the main reason is related to the low educational level of youngsters in the interior and gold mining is an economic activity that does not demand high investment and skills.

With the end of the conflict in 1992, the Surinamese artisanal miners, porknockers, increased their activities. In the Royal Hill, located in the Nieuw Koffiekamp area, the OAS team interviewed a group of panners who reported that the high grade ore was processed by panning whereas the low grade material by a small pump and sluice boxes. Processing 250 kg of alluvial material, a panner made a maximum daily production of 1 g of gold, considering that he lost 1/3 of the gold and the ore grades 6 g/tonne. In zones of high grade alluvial material, panners have recovered as much as 114 g of gold/tonne of ore processed. It was noticed that a miner working for 8 months per year could produce 160 g of gold that represents over US\$ 1200 of income after deducting the operating costs. As each miner must give 1 g Au per month for the village fund, Nieuw Koffiekamp could receive annually 1,400 g of gold from its 175 miners. Now, all artisanal mining activities in this area are considered illegal as Golden Star Resources owns the legal titles for exploration.

Recently, another protagonist appeared in the Suriname gold mining sector: the Brazilian “garimpeiro”. The presence of “garimpeiros” changed the concept of artisanal mining traditionally used by the Maroons for subsistence or as an “emergency resource”. Porknockers have been exposed to hydraulic monitors, bulldozers, excavators, dredges, and other semi-mechanized mining methods that have improved gold production by increasing production scale. The concept of mining for subsistence was replaced with mining for profit, for better living conditions. In some respect, the presence of “garimpeiros” brought to Suriname a “gold fever” that have reached some Maroons and local entrepreneurs who adopted the “garimpeiro” mentality of producing as much gold as possible, as soon as possible, with no concern for the environment. The Brazilian invasion is also degrading moral and social standards and displacing local laborers, as “garimpeiros” are hard and experienced workers.

In an interview with Mr. José Cardoso Neto, a Brazilian economist who is organizing a Cooperative of artisanal miners in Suriname, he believes that the number of artisanal miners is something around

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<sup>3</sup> Healy, C. (1996). Report on the Situation in Nieuw Koffiekamp. OAS Special Mission to Suriname. 144p.

<sup>4</sup> Maroons communities were established in the 1700s. They are descendants of the run-away slaves.

15,000 in which 10,000 to 12,000 are Brazilian “garimpeiros” and the rest are local porknockers. In the Ministry of Labor, there are 8,000 Brazilian “garimpeiros” legally registered. There are already about 1,000 families of Brazilian “garimpeiros” living in Paramaribo with sons using the public education system. However, most “garimpeiros” in Suriname are “mining laborers” who have never owned mineral titles in Brazil<sup>5</sup>. Interviewing many “garimpeiros” in Paramaribo and interior, they reported that the main reasons by which they come to Suriname are the following:

1. Rumors in the Brazilian goldfields (Itaituba and Boa Vista) that Suriname is the new “Eldorado”.
2. No difficulties to obtain work permit in Suriname (costs US\$ 200/permit) for one year that can be renewed.
3. Enforcement of the Brazilian federal police removing “garimpeiros” from illegal areas in the Amazon.
4. End of the easily exploitable alluvial gold in Brazil.
5. Surinamese miners like “garimpeiros” because they have “mining technology”.

The organization of the Artisanal Miners’ Cooperative<sup>6</sup> is in good terms with the Surinamese Government. Influential businessmen involved in the gold business are helping Mr. Cardoso Neto organize this Cooperative for “garimpeiros” and porknockers.

The conventional ways by which Brazilians enter Suriname, i.e. plane and ship, are not accessible for poor “garimpeiros”. Many of them enter Suriname travelling from Belém (capital of Pará State in Brazil) to Iapoque (city located at the most northern part of Brazil) and from there they take a home-made raft locally known as “catraia” to reach French Guiana. This trip takes one night and many “garimpeiros” have lost their lives in this journey. From French Guiana, Brazilians take a bus to Suriname and pay local facilitators to alleviate the legal immigration procedures. Quite immediately they find jobs in the mining sites. There are hotels and bars in Paramaribo which are meeting points for Surinamese entrepreneurs to hire Brazilian workers. Many Brazilians are very pleased to be in Suriname as local people are friendly and there are many opportunities for working. It is interesting to notice that “garimpeiros” have never used the word “mining” during the interviews, but just “working”. This mirrors the hard life of these individuals roaming from one place to another, looking for living alternatives using jungle resources since they have not had opportunity of being settled in any place in Brazil mostly as a result of inequities in rural-land ownership policies.

Brazilian “garimpeiros” are targets of group of bandits who attack them to steal gold and sometimes equipment. Brazilians are paying a local organization to have “protection”, but in fact no service is provided. The monthly cost for this protection is US\$ 700/dredge, 5 g Au/worker or 20 g for those workers using metal (gold nugget) detector.

Recently the conflicts between “garimpeiros” and bandits resulted in deaths of two bandits. Somehow, Brazilians are being encouraged by the Surinamese police to react against those bandits (Commandos).

The conflicts are not restricted to “garimpeiros”. The local porknockers are also facing problems with mining companies. As Golden Star Resources (GSR) shut down all artisanal mining activities of Nieuw Koffiekamp in the Gross Rosebel concession, the village economy declined drastically. Despite other activities, such as agriculture, fishing, rubber, logging, mining is by far the most

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<sup>5</sup> These “garimpeiros” roam from one site to another looking for work.

<sup>6</sup> According to Suriname laws associations or syndicates are available only for Surinamese citizens.

significant source of income as well as a traditional subsistence way for the villagers. The idea to have part of the GSR concession available for artisanal miners has not been well accepted by the company since the feasibility study of the whole area is not completed yet but the possibility of a peaceful coexistence of porknockers and GSR has been considered. Some illegal artisanal miners are still working in the GSR concession, but armed enforcement has been applied to remove all miners from the area. It seems that the foreign company has not been properly approached the local community. In January 1995, a governmental delegation began to talk with artisanal miners. This resulted in an agreement that 8,000 ha will be reserved for small-scale mining operations. This measure was not quite welcomed by miners as they must build roads to reach the alternative mining areas. At the end of March, miners returned to the Gross Rosebel area. The discord is not easy to solve, as the issue is fraught with political and social issues. The mineral rights are in conflict with the ancestral rights established since the beginning of the 16<sup>th</sup> Century by the Maroon society. Many of the rights granted to the Nieuw Koffiekamp community by the 1992-Peace Accord did not come true, i.e. the “priority right” to the villagers to conduct small-scale mining in the designated “economic zones” has never been issued by the Government.

Gold production in Suriname is not well established. In spite of the excellent price practiced by the Surinamese Central Bank (0.93 x refined gold price + royalty of 3%) gold smuggling is still occurring for money laundering. The Chinese jewelers have been pointed as the main smugglers. The lack of control of gold purchase in the interior makes easy smuggling. The Central Bank is establishing a purchasing program in the interior, but at the moment many miners go to the capital to sell gold to one of the 8 gold dealers. Very frequently, miners are robbed on the way to the capital.

The Geological Mining Services (GMD) do not have information about number of artisanal miners. Actually GMD, which in the past was a very active institution, nowadays it does not have enough funds for inspection and its presence in the interior of the country is almost nil. Many professionals working in the mining sector have idea that about 8,000 artisanal miners are working in Suriname, producing 8 tonnes of gold annually. According to information of Mr. Harold Pollack, former Ministry of Natural Resources, in 1996 the Central Bank bought 3 tonnes of gold, 3 tonnes of gold were smuggled to Miami by local entrepreneurs and other 2 tonnes of gold were likely illegally exported to Hong Kong. Mr. Cardoso Neto, as well as many Brazilian “garimpeiros”, believes that between 10 to 12 tonnes of gold are being produced annually in Suriname by 15,000 miners.

Miners are dispersed in approximately 20,000 km<sup>2</sup> of the Surinamese greenstone belt in 10 main regions (see map in Appendix 3):

1. North Lake area, where Brokopondo is the main village.
2. Goliath area.
3. Lower Marowijne River area.
4. Lower Saramacca River area.
5. East Brokopondo Lake area.
6. Langatabiki area
7. South Lake area including Sara creek and Marowijne creek.
8. Upper Saramacca area.
9. Tapanahony River area including Sela creek area in the Middle Tapanahony River.
10. Lawa River (French Guyana border) area where Benzdorp is the main mining site.

A paper presented at the Suriname Mining Conference'97 in Paramaribo on January 1997 by Mr. Rubin Lie Pauw Sam, chairman of Wylap Developments and Mr. Patah Pawiroredjo, head of the PPA Engineering Services, estimates that gold production in 1996 could be as much as 30 tonnes.

### **Gold Processing Technologies in Suriname**

The mining and mineral processing methods used in Suriname by artisanal miners are outlined in the Table 1. The hydraulic monitor using pumps of 4, 6 inches and sometimes 10 inches is by far the main mining method to extract gold from alluvial, colluvial and elluvial material. About 3,000 units are currently in use in Suriname. Quite often, the hydraulic monitors work near watercourses. The misuse of this mining process silts up waterstreams and spread tailings on the ground. Differently from other countries, the Surinamese miners started mining colluvial terraces before knowing the potential of the alluvial material in rivers and creeks. One reason for this, can be the fact that colluvial terraces are very close to gold sources. Quite often, the quartz fragments show angular shapes and the lack of liberation of gold from quartz pebbles is evident. Another reason is the high grade of the colluvial terraces.

Table 1- Outline of the Gold Extraction Processes Used in Suriname

<b>Mining/ Processing Method</b>	<b>Type of Ore Mined y</b>	<b>Number of workers in each operation and (hours/day)</b>	<b>Investment (US\$)</b>	<b>Gold Production (grams/day)</b>	<b>Division of the earning</b>
Metal detector for nuggets	laterite & saprolite	3 to 4 (12 h)	1,000	100 - 300	10% concession owner 90% equipment owner
Manual/ Hammer mill/ Pan or sluice	quartz-rich elluvial or veins	8 (24 h)	6,000	200-800	10% concession owner 10% equipment owner 80% for the laborers
Manual Shovel/ sluice box	colluvium	2 (12 h)	1,500	5-15	Sharing with partners
Hydraulic monitor 6"/ sluice box	colluvium & alluvium	5 (12 h)	24,000	30-100	10% concession owner 30% for laborers 60% equipment owner
Bulldozer + Hydraulic monitor 6" /sluice box	colluvium & alluvium	7-14 (12-24 h)	24,000 + Bulldozer rental	100-300	10% concession owner 20-25% for laborers 70% equipment owner
Gravel dredge/ sluice box	alluvium in rivers & creeks	4-5 (12-24 h)	40,000	100-300	10% concession owner 15-20% for laborers 70-75% equipment owner
Guyanese missile dredge/ sluice box	alluvium in rivers	7 (24 h)	100,000	500-800	10% concession owner 15-20% for laborers 70-75% equipment owner
Brazilian dredges 12"/ sluice box	alluvium in rivers	7-8 (24 h)	150,000	1000-1500	10% concession owner 15-20% for laborers 70-75% equipment owner

Source: Adapted from R. Lie Pauw Sam and P. Pawiroredjo (1997). *Gold Opportunities in Suriname. Paper presented at the Suriname Mining Conference'97, Jan. 25-26, Paramaribo.*

The gold grade of colluvial and alluvial terraces is variable. Miners usually extract 0.1 to 0.2 g/m<sup>3</sup> of gold from the surface clayey material. This top layer varies from two to ten meters. Immediately below, there is a gravel layer not thicker than one meter usually containing 0.4 to 0.7 g/m<sup>3</sup> of gold. This is typical of the terraces of the Marowijne River. In other terraces, such as those in the Sara creek region, the gold grade doubles. Interviewing, miners from Paquira River, near Marowijne

River, on the border of the French Guiana, the informed production accounts for 20 g Au/day (200 m<sup>3</sup>/day of ore with 0.1 gAu/m<sup>3</sup>) from top layers of alluvial terraces. The gold produced is split and miners receive 30% to be divided among 6 workers. So, each worker receives less than US\$ 9/day. Asked if this meager result pays all his effort, a Brazilian “garimpeiro” said: “mining is a worm inside of me that destroys me but I cannot get rid of it”. With this income he pays his personal bills and sends some money to his family in Brazil. As stated by the miner, this “salary” is much higher than the minimum wage paid in Brazil for a peasant like him. Actually, he is dreaming on finding better ores elsewhere, someday.

In the saprolitic material, sometimes forming superficial lateritic crusts, gold grades are extremely high and formation of large nuggets is usual as a result of gold transport (adsorbed onto the hydrous ferric oxides particles) followed by recrystallization. In Sara creek, a 7-kg gold nugget was recently discovered in the colluvial terrace at the basis of a hill that holds the bedrock. The nugget was likely transported a few meters from the saprolitic material to the terrace. Very few people in Suriname use crushers or are aware that they need to liberate gold from lateritic crusts and quartz fragments.

It is interesting to note that some foreign mining companies are using Auger drilling to investigate gold content in soil. The method causes low environmental impact and is appropriate for geochemical assessment. However, one-kg sample obtained from 1 meter-Augur drill hole is not quite adequate to establish reserves for placer mining. This is an indication that likely these mining companies are aiming at the primary ore with less interest for the surface material. In this case and in principle, the co-existence of mining companies with artisanal miners should not bring conflict of interests. Evaluation of gold reserves by opening trenches, as employed by Golden Star Resources, is more appropriate for placer deposits. This is also part of the “garimpeiro” culture. When interviewed, a “garimpeiro” said that his exploration (“research” as he said) program consists in processing one tonne of material from a same pit in a small sluice box. Repeating this procedure to other sites, he establishes his “mining plan”.

A hydraulic mining operation with two 6” monitors usually exploits 4 to 5 m<sup>3</sup>/hour. With 10” monitors, the production achieves 7 to 9 m<sup>3</sup>/h. The operation is frequently associated with riffled (or not) sluice boxes lined with carpet. Three to four miners conduct the mining operation: one or two people handling monitors, one operating the pump that sends material to the sluice boxes and removing trunks from the pump entrance and one controlling the pulp flow in the sluice box. The concentration system employs 2-deck sluice boxes arranged in Z shape in such a way that the second deck retreat the tailings from the first deck. The slope of the boxes is approximately 5%. The upper deck is 2.80m long and 1.80m wide and the lower one is 2.80m long and 1.65m wide. Usually, the operation lasts one week to 10 days and the mass of concentrate ranges from 50 to 70 kg. The concentrates are manually removed from the boxes to be submitted to amalgamation.

During the dry season most of the mining activities are suspended. The semi-mechanized operations are diverting creeks to create water reservoirs and water is quite often reclaimed in a very inefficient way. Neither tailing pond nor thickening are employed. The tailings simply flow on the ground and water is collected in excavated pools.

In Sara creek, three brand new units of the Canadian centrifuge Knelson Concentrator, acquired by Sarakreek Resources Co<sup>7</sup>, are not operating due to the lack of clean water to promote an adequate

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<sup>7</sup> Joint venture between Canarc Resources and Wylap Development

fluidized bed in the centrifuge bowl. The lack of skilled operators and technical assistance are also reasons why this remarkable equipment is not being used. Currently, Sarakreek hired 25 Brazilian “garimpeiros” and brought 5 miners from China to employ hydraulic monitors and sluice boxes. The gold recovery is between 1 and 2 g/m<sup>3</sup>. Working in groups of five, each worker receives 4% of the gold production plus other benefits such as medical assistance, housing, air tickets and food. Miners are very happy with this system. The company is proud of not using mercury. Once a week, the concentrates are taken to a gold shed to be processed. The fraction –4mm is fed into a 7.5” Knelson Concentrator. After 15 min., the concentrate is discharged and screened on 2 mm and 1 mm screens. The tailing from the Knelson centrifuge is sent to a pond passing through a scavenger sluice box. The screened fractions: -4,+2mm, -2,+1mm and –1mm are panned by Chinese miners using a sort of flat batea. The process takes hours and tailings are still rich in gold. The company is looking for alternatives to improve recovery and reduce time. Very likely amalgamation will be adopted for fine fractions.

In most cases in Suriname, miners do not perform efficient bush cutting before starting their operations. They simply slash the large trees and burn the rest. They do not have any information and concern about the use of the original soil for revegetation purposes. In addition, debris brings enormous problems for the hydraulic mining operation by clogging the pumps.

### ***Amalgamation Process in Suriname***

Amalgamation is widely used in Suriname in various ways:

- Mercury is placed in the riffles of the sluice box to contact the whole ore.
- Mercury is spread on the ground to mix with the whole ore in some hydraulic mining operations.
- Mercury is used to amalgamate only gravity concentrates.

In most mining sites visited, Brokopondo, Dabikwen, Brownsweg and Sara creek, miners were amalgamating only concentrates but news about poor amalgamation practices in Suriname are extensively told by local miners. Some miners still believe that spreading gold on the ground the “magic” metal chases gold specks to form amalgam. The illusory effect is caused because mercury droplets and gold particles meet each other on the sluice box giving impression that amalgam was already formed on the ground. This insane practice seems to be declining in Suriname for economic reasons and because more “knowledge” has been brought by Brazilian “garimpeiros” who have employed for long time this method. However the use of mercury placed in sluice boxes is still significant. When the whole ore is amalgamated, the mercury losses can be as high as 3 times the amount of gold produced. No benefit is observed when sluices operate with mercury on riffles. Amalgamation is inefficient and abrasion tends to cause mercury flouring. Amalgamation of concentrates must be suggested to miners as a measure to reduce this type of mercury emission.

In most operations in Suriname, at the end of the concentration cycle, which lasts from 7 to 10 days, the concentrate retained in the sluice boxes is washed exhaustively to remove excess quartz particles. The large fragments are removed manually. In some cases, the sluice boxes have a recipient to trap large gold nuggets. Concentrates are removed to be amalgamated in pans or mercury is spread on top of the concentrate and amalgamation occurs on the sluice. In this case, operators rub mercury droplets onto the heavy concentrate to “guarantee” amalgam formation. This expedient avoids further panning operation to separate amalgam from heavy minerals. In addition, the amalgamation is inefficient and when heavy minerals are washed out, mercury and gold is lost. Talking to a miner

about this, his explanation for using this unique amalgamation method was to obtain amalgam as fast as possible for safety reasons. Using the same argument, he justified the fact that he does not use retorts to decompose amalgams.

When concentrates are amalgamated in the pan, this operation is conducted in excavated pools forming “hot spots”, i.e. sites with high mercury concentration. Very likely there are lots of hot spots dispersed in the Surinamese jungle. Miners add 2 parts of mercury to amalgamate 1 part of gold. In general, as declared by some miners, half of the mercury added is recovered when excess of mercury is squeezed off. The other half is lost when amalgam is burned. This gives the typical ratio of  $Hg_{\text{lost}}:Au_{\text{produced}} = 1$  as observed in many Latin American countries<sup>8</sup>.

Very few miners know a retort. Miners burn amalgam in open bowls or on top of a machete. Some miners place a piece of leaf between their face and the blowtorch to “protect” them against mercury vapors. As some droplets are condensed on the leaf they believe that most mercury is recovered and they are safe. Most Brazilian “garimpeiros” said that they have used retorts in other “garimpos” in Brazil, but they can not find affordable large retorts in Suriname. In Suriname there are different types of retorts being sold. An American retort made in Oregon State, with capacity of retorting 50 grams of amalgam, costs US\$ 20. A Brazilian retort, with larger capacity (250 g of amalgam) costs US\$ 200, including the gas tank and burner. Dr. Quik, from Universtiy of Suriname, made a retort following the design of the RHYP retort<sup>9</sup> using pipes and water connections. This costs less than US\$ 10 and the size of the retort can be adapted to burn 1 kg or more of amalgam.

Retorted gold, that usually contains from 2 to 5% of residual mercury, is sold to one of the eight gold dealers in Paramaribo, registered by the Central Bank. Gold is melted under the miner supervision before being weighed and paid. The Central Bank enforces the use of condensers for mercury abatement during the gold melting operation. Many Chinese jewelers pay better price for gold brought by miners to Paramaribo. They do not use any safety protection or filter to melt gold.

Recently, the OAS (Organization of the American States) Mission to Suriname supported a US\$ 76,000 project to assess mercury contamination levels in water, sediments, fish, urine and hair. With a multidisciplinary team of 6 professionals, five mining areas were visited:

- Brokopondo
- Langatabiki
- Lawa River (Cottica area)
- Drietabiki/Selakreek
- Matawai

About 45 water and sediment samples, 25 fish samples of different species, 200 hair samples and 125 urine samples, including 50 urine samples from workers in Chinese gold shops in Paramaribo were collected by the OAS team. Water, sediment and fish will be analyzed by the British Geological Survey, hair by a Canadian laboratory and the urine by a University lab in Holland (Leiden). There is no analytical facility for mercury analysis in Suriname. The project had a very practical orientation and close relationship with the University of Suriname (Dept. of Environmental Science, Dr. Jan

<sup>8</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>9</sup> Veiga, M.M.; Meech, J.A.; Hypolito, R. (1995). Educational measures to address Hg pollution from gold mining activities in the Amazon. *Ambio*, v. 24, n.4, p.216-220.

Quik) and Diakonossen Hospital, Dept. of Pharmacy (Mr. Jules de Kom). Groups of mercury poisoning risk were selected in this pioneer project in Suriname. The results of this preliminary investigation are not available yet. The project distributed 70 of Brazilian retorts to promote this simple technique on the mining areas. Beyond mercury pollution, the project also pointed other environmental problems related to water siltation. As water is scarce in some region, this is creating conflicts between miners<sup>10</sup> and villagers.

At the moment the environmental assessment reports of artisanal mining activities do not bring quantitative data. Most of the mechanized mining activities are just starting. The pits on the colluvial terraces are still shallow but expanding rapidly. Satellite images (e.g. 1:200,000 Landsat images) can provide an approximate idea about the evolution of the mining operations in the last ten years. This methodology, in spite of its limitations, has been successfully used in monitoring Brazilian “garimpos”. The environmental effects of the mining activities seem to be localized with influence on water quality and biomass of local creeks. As yet and apparently, the environmental effect on large waterstreams does not seem significant as yet but there is potential for a dramatic situation in a near future as the number of miners is increasing exponentially and no control is enforced by the Government in the interior.

The effect of mercury accumulation on fish from the Brokopondo hydroelectric reservoir is unknown but is another point of apprehension. The phenomenon of increasing Hg bioaccumulation in artificial lakes has been recognized in many countries. Almost 30 case studies of high Hg levels in fish in man-made reservoirs are reported by Stoke and Wren (1987)<sup>11</sup>. In many cases, mercury sources were not identified but the influence of the submerged vegetation, type of organic matter and bacteria in flooded sediments are recognized. Organic matter plays a significant role in mercury mobility as complexes<sup>12</sup>. In impoundments, atmospheric mercury from different industrial sources, mostly combustion processes, is deposited for years on top layers of the soil. Some microorganisms are capable of promoting mercury methylation and others demethylation, i.e. transforming Me-Hg into metallic mercury. Because Me-Hg production in sediments results from a reversible process, the actual Me-Hg production may be governed by how quickly the Me-Hg is removed from the sediments into overlying waters. Inorganic mercury polluted environments can reach equilibrium between the methylation and the demethylation activities of the bacteria communities. In other words, the competition between bacteria which demethylate and bacteria which methylate will determine the rate and extent of Me-Hg produced. The conditions created when soils are flooded appear to favor bacteria community which methylates. This increases the methylation rate. This effect must be measured in the Brokopondo Lake as local communities count on fish from the reservoir for their source of protein. It seems that the mercury contribution from mining to this artificial lake is still minor.

### ***Women and Children in the Surinamese Artisanal Mining***

As indicated by Mr. Healy<sup>13</sup>, a few women are involved in panning activities. Children and teenagers also work around the mining sites. In Brokopondo region, it was noticed a group of 10 children from Nieuw Koffiekamp panning for gold in a “hot spot” (an amalgamation pool) created by a mining

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<sup>10</sup> Some of the miners are originally from the village that they are contaminating.

<sup>11</sup> Stokes, P.M. and Wren, C.D. (1987). Bioaccumulation of Mercury by Aquatic Biota in Hydroelectric Reservoirs. Chapter 16, SCOPE 31. John Wiley, New York, p.255-277

<sup>12</sup> Tromans, D.; Meech, J.A.; Veiga, M.M. (1996). Natural Organics and the Environmental Stability of Mercury: Electrochemical Considerations. J. Electrochemical Society, v. 143, n.6, p. L123-126

<sup>13</sup> Healy, C. (1996). Report on the Situation in Nieuw Koffiekamp. OAS Special Mission to Suriname. 144p.

operation<sup>14</sup>. This is convenient for the youngsters, as they know that they can recover gold and mercury. All kids, with age between 8 and 12, had in their batea 1 gram of amalgam + excess mercury. They play with mercury ignoring the danger of mercury vapor. They bring home their amalgams to be burned by their parents likely in their houses. This must be investigated as serious domestic poisoning can be occurring.

Women are also very active in the Brokopondo region in collecting gravels from the river and creeks for civil construction purposes. They leave piles of stones by the roads to be collected for a truck.

Farming has been the main activity of the villages in the interior. Currently, families are being destroyed as men are being more involved with semi-mechanized artisanal mining and moving to other mining regions. No visible benefit is being seen in the mining villages, but just some entrepreneurs selling equipment and controlling the prostitution in villages.

Prostitution in Paramaribo is increasing rapidly. Local businessmen are bringing women from Dominican Republic and Brazilian Amazon region to work in night clubs. Women are lured by receiving an air ticket that they must pay back with 100% of interest. They rent rooms in the night clubs paying 30,000 guilders (US\$ 71) per month. These women work seven days a week and, as frequently they cannot pay their bills, they become slaves. The only way to leave is paying their “debt” to the club owners. Most of women know that they can make more money on the mining sites, but they are afraid of violence, AIDS and malaria. Paramaribo has also been a way for these women to travel to Holland as the club owners have connection in that country.

As the Maroon society is based on a matriarchal structure, women must be used as important couriers of information to influence their communities to change their poor amalgamation and mining practices. Programs and projects in Suriname to reduce mercury emissions must have a strong component focused on women, as they are the most sensitive victims of mercurialism.

### ***The New Mining Code, the Minerals Institute and the Artisanal Miners***

The Suriname Government has received consulting support from the British Geological Survey to prepare a concept for a new Mining Code which is the basis to establish a Mineral Institute that will incorporate the Geological Mining Service (GMD). The European Union is prepared to spend US\$ 4 million dollar in setting up this new institute that will have legal and fiscal attributions as well as be the Surinamese Geological Survey. The document<sup>15</sup> prepared by a BGS geologist and an International Mining Lawyer from Portugal, in November 1997, makes suggestions for a new Mining Code and shows the main framework of attributions of the Minerals Institute. It is an outstanding document in which a vast number of items concerning mining and environmental impacts were approached. The chapters related to artisanal mining are commented as follows.

The document suggests that the existing five category of minerals classification should be changed to two categories: *mineral deposits* (which encompass all metallic and non metallic minerals) and *mineral masses* (which comprise dimension stones and minerals for civil construction). The right of *small-scale mining* can only be granted for mineral deposits, as established in the Article 53. In this case, those women picking gravel in Neuw Koffikamp and Brownsweg will be illegal (?). The same

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<sup>14</sup> Testing this hot spot with a small amalgamation plate, it is inferred that the Hg concentration is higher than 3 ppm.

<sup>15</sup> British Geological Survey (1997) in collaboration with Cristina Lourenço. A Concept for a New Mining Code and Standard Mineral Agreement for the Republic of Suriname. Draft Report, November 1997, 100p.

article also suggests that *small-scale mining operations can only be carried out in reserved areas unless there is a possibility of co-existence. Indigenous people may have a priority to conduct small-scale mining activities.* The possibility of co-existence *between indigenous people carrying out illegal small-scale mining and companies* exists as long as a letter of understanding is presented. The Article 57 establishes the reserved areas:

- a) *two parcels of 2 ha (4 ha) for individual miners;*
- b) *ten parcels of 2 ha (20 ha) for associations of ten person.*

The suggested definition of small-scale mining is actually attached to the working area and production size: *“The reconnaissance, exploration and exploitation of a mineral deposit whose nature, mode of occurrence and quantity warranty economic mining by sustainable, simple means and technique, where production is less than 100,000 tpy r.o.m., mineral reserves in designated areas comprising one or more 2 ha contiguous rectangles, the total not exceeding 20 ha.”*

*“The Minister must publish in the Official Gazette the areas assigned to small-scale mining with the description of the minerals for which this is applicable. Areas already subjected to mining rights are closed for small-scale mining, unless there is a possibility of co-existence.”*

BGS also suggests that the right of *small scale-mining* should be limited to natural persons, over 18 years old and resident of Suriname. The Mineral Institute will be in charge of issuing *small-scale* mining rights recording the following information:

- a) *identification of the grantee of the rights*
- b) *delimitation of the area covered*
- c) *the type of mineral deposits in respect of which small-scale mining rights are granted*
- d) *the term and conditions for prolongation*
- e) *the royalty (1% of the market value of the minerals exploited)*
- f) *other specific provisions such as a work program, technical procedures, health and safety and environmental protection provisions appropriate to the level of production.*

Reading this document, I am reminded of an old story that a Chinese friend of mine told me about how to make pathways in public parks. He is always surprised why occidental people step on the lawns in the parks not using the cement pathways. He said that in his city in China, when a park is constructed, no grass is planted for one month. After observing where people walk, they make the lawn and the pathways. The same story is applicable to the part of the BGS document related to *small-scale* mining. Why BGS do not see what is going on in the artisanal mining sector in Suriname or in Latin America and try to elaborate something more realistic? Who are those *small-miners* described in this document? I have not seen any in Suriname! According to the BGS suggested law, all gold miners in Suriname are currently illegal.

The artisanal mining sector in Suriname is much more complicated than in other countries. There are site-specific characteristics, such as tribal cultures, ancestral rights to the land and tradition of mining as a familiar concern that must be respected. The document brings important contributions for the formal mining sector, but the BGS must observe carefully where 15,000 people are “walking” before suggesting the “pathways”.

In the BGS suggestion, the definition of *small-scale* mining is attached to size of the operation and location. As mining is part of the culture of many Maroons the relocation of entire tribes to the “designated areas” seems to be impractical. It is understandable that creation of *small-scale* mining reserves is a measure to protect miners as most of the prospective areas are already stacked by companies and few individuals, however all titles MUST BE TRANSFERABLE. This important detail is not mentioned in the BGS report. This guarantees that a mineral title will be an asset for an artisanal miner. This implies that miners will develop a sense of respect and protection for their properties consequently reducing environmental impacts. Since Serra-Pelada in Brazil, the “garimpeiro” reserves have isolated miners and concentrated pollution in most parts of the Amazon. If the creation of reserves is a real intention of the Surinamese Government, the Mineral Institute must be prepared to provide technical assistance and have provisions for environmental rehabilitation. In this case a royalty<sup>16</sup> of 0.25% of the gold production will not be enough for this hard job.

The term small mining does not imply in informal or rudimentary operations but indicates just the size of the operation, which in the case is suggested to be smaller than 100,000 tonnes per year (?). The term artisanal miners must be preferred to encompass all small, medium, large, informal, legal and illegal miners who use rudimentary processes to extract gold from secondary and primary ore bodies. Rudimentary means all semi-mechanized processes that do not follow the conventional mining process. This is not difficult to evaluate. This will be clear and visible when an individual or company fill the forms in the Minerals Institute to obtain a permit. The identification of an artisanal mining operation will be a result of the identification of the individuals or companies involved, how technically and economically skilled they are, which grade of mechanization is employed, which mining plan is established rather than define the activity by the size or type of ore. The technical approach to extract minerals will clearly distinguish between an artisanal and a conventional miner.

The idea of co-existence between mining companies and indigenous miners is vague in the document and deserves more attention. There is no clear definition about who has priority to the mineral title: who discovered the ore (small-scale mining rights) or who has advanced technology to exploit it (exploitation rights).

Mr. Michael Allison, president of the International Agency for Small-Scale Mining, a Montreal-based non-governmental organization, has declared that “small-scale mining is a natural phase in mineral development in developing countries”. Currently Suriname is living a paradoxical situation as artisanal mining represents a labor intensive activity in the interior of Suriname, which accommodates non-skilled workers and moves an informal economy as large as US\$ 150 million but at the same time creates conflicts with the formal sector and destroys the environment.

*“Properly managed mining operations are much less damaging than they were in the past. Smaller mines, and particularly artisanal operations in alluvial materials, tend to be much more destructive.”* This statement in the BGS document is quite true, but environmental concepts established in developed countries signify resource use and survival for many developing people. The challenge is to teach artisanal miners how to conduct environmentally sound operations.

A way to conciliate the artisanal mining activities with a modern concept of sustainable development is establishing the same rights to artisanal miners as the ones of mining companies. The duties

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<sup>16</sup> The Article 82 of the BGS document suggests that 0.25% out of 1% of the royalty paid by miners goes to the Minerals Institute. In Guyana the royalty received by the Guyana Geology and Mining Commission is 5% of the gold production.

cannot be the same. Companies are closer to the Government than artisanal miners. Companies are organized and can afford technical support, miners cannot. The Government must find ways to alleviate the bureaucratic and fiscal charge to accommodate artisanal miners into the law. The South American History is full of examples of laws and onerous taxes that create nothing but more illegality. These miners have to evolve to be part of the mainstream of the Surinamese economy and society. This will not happen if they stay isolated. They must be taught how to organize themselves and how to have profitable operations respecting the environment. Education is clearly the first step, organization the second and legalization the third. Currently, all gold mining activities in Suriname are conducted in an artisanal way, so a new Mining Code will not bring abrupt changes to this scenario but can create more conflict if does not contemplate the trait of the Surinamese miners.

A very positive point of the BGS document is the Article 6 about the technical assistance and elaboration of a *Manual of Procedures for Small Scale Mining* by the Minerals Institute. The Minerals Institute shall also have attributions of training miners:

*“The Minerals Institute shall be enable to create training centers for small-scale miners located on the basis of a mineral evaluation of the possible sites, or located at existing artisanal mining sites, or through integration with a regional administrative office or economic decentralization project center in a specific area of the country.”*

A new National Institute for Environment and Development (NIMOS) was established on November 17, 1997. The Institute was set up as a foundation reporting directly to the Suriname’s President and an Environmental Council. The IDB (Interamerican Development Bank) has provided technical assistance through international consultants to implement NIMOS. As well, a US\$ 2 million-dollar support will be a significant kick-off provision to operate this Institute.

NIMOS will operate with seven offices:

1. Administration
2. Environmental Assessment/Enforcement
3. Education and Awareness
4. Environmental Funding and Investments
5. Legal Services
6. Environmental Information and Planning
7. Environmental Research and Sector Coordination

The BGS document suggests a close collaboration of the Minerals Institute (MI) with NIMOS. The EIA (Environmental Impact Assessment) for *exploitation rights* must be submitted to NIMOS for analysis before being approved by MI. The applicants for *exploration rights* do not need to elaborate EIA but other documents such as Environmental Baseline Protocol and Community Impact Protocol. For *small-mining rights*, an environmental protection provision must be anticipated but there is no detail about this in the BGS document.

## Foundation of Experimental Mining

In 1996, a group of professionals led by Mr. Gemerts from the Surinamese GMD, Mr. Noter from Central Bank of Suriname and Mr. Healy from OAS Special Mission to Suriname prepared a document titled “Small-Scale Mining in Suriname: Problems and Opportunities”. This paper reports the boom of the artisanal mining activities in Suriname, denounces foreign miner invasions and

destruction of the environment. One of the main points highlighted by the authors is the lack of presence of Government in the mining zones of Suriname. Many years ago, GMD operated a training camp for small-scale miners at Lokst Ati near lower Saramacca River. A manual was written for training sessions. The GMD resources, including personnel, became limited and the training facility was shut down. The document recommends the establishment of a Foundation for Experimental Mining as a way to train miners in the interior under realistic conditions. The Foundation would be self-sustained, as the operations would produce enough gold to support the training program. This actually was the basis of a project presented to USGS in 1995 by GMD that unfortunately did not come true. The project had a budget (6 months) of US\$ 50,000 to introduce a first training facility in the interior.

This excellent idea was developed together with Mr. Christopher Healy (OAS) during my stay in Suriname. UNIDO has been promoting the idea of establishing Amalgamation Centers (UNECA) based on the successful initiative of Venezuelan Government and private companies<sup>17</sup>. The concept of UNECA Centers was originally<sup>18</sup> conceived to provide amalgamation services, decontamination services, gold purchase and educational support for miners and general public. The concept was actually expanded. Miners can enhance their technical and economic skills with training in basic notions of geological exploration, mining and mineral processing techniques. Of course that the training units must be adapted for different countries to accommodate specific geographic and legal situations. In Suriname the idea of the Foundation of Experimental Mining as aspiration of local professionals and Government, fit very well with the concept of UNECA centers and the structure was adapted to incorporate specific points.

The Foundation of Experimental Mining (FEM) was conceived to operate Experimental Mining Centers (EMC) in the interior. The training units transfer knowledge to miners working under realistic conditions at the mine sites. Specific mining claims must be designated to be used as experimental mining areas. While producing gold, miners are exposed to concepts of geological exploration, ore reserve estimation, mining and concentration techniques, environmental impact, water reclamation, tailing pond building, revegetation, bookkeeping, etc. In addition, the Center can improve the economic and social welfare of artisanal miners and their families providing advice on how to obtain legal mineral titles and financial support, how to plan a mining operation, how to avoid occupational exposure, how to start alternative economic activities and other family matters. These Centers play also an important role to bring information to general public about mercurialism caused by Hg vapor and contaminated fish ingestion. Brochures, posters, videos and other communication material may be distributed. For those who insist in conducting their own amalgamation, they receive instructions how to make their own retorts using plumbing water connections. The Centers can also be a meeting place for miners to exchange their experiences and have moments to socialize and organize themselves.

The University of Suriname can play an important role providing and forming trainers for the Centers.

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<sup>17</sup> Veiga, M.M. (1996). *Advisory Assistance on Avoidance Mercury Pollution from Artisanal Gold Mining Operations in Bolivar State, Venezuela*. Report prepared for UNIDO, 140p.

<sup>18</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.

Similar idea has been used by a Canadian company, Placer Dome in Las Cristinas Project, Venezuela to establish a co-existence program with artisanal miners<sup>19</sup>. Since 1993, the company has assisted miners to organize themselves and a small-scale mining project has been carried out. This includes the construction of a miners' center, establishment of exploration programs and metallurgical testwork for ores. The results are built step by step but at least discipline was already introduced in the project area and no armed force was adopted. All differences of opinion are discussed and negotiated.

The Foundation of Experimental Mining is a concept with potential to be transformed into real solutions for artisanal miners in Suriname, but the commitment of miners, Government and private companies is significant for the success of the program. A preliminary document with description of all concepts associated with the FEM is found attached to this report (Appendix 1).

The cost of implementing this project is sensitive to site-specific aspects and extremely dependent on which type of Center is adequate for a region, whether the Center will have training unit or not. As well, the cost depends on availability of building, labor, materials and local infrastructure. It is expected that something around US\$ 300,000 will be needed to establish the first ECM in Brokopondo. A detailed budget must be prepared based on field evaluation. The previous step to implement this project must be an exhaustive discussion of the fundamentals of the FEM with miners and local communities. For this, the Minerals Institute must be established and prepared to conduct this project.

## Conclusion

The artisanal mining activities in Suriname are increasing rapidly and there is potential to double in few years due to:

- Lack of Government control on mining operations.
- Lack of opportunities for unskilled people in the interior.
- High cost of living in the interior.
- Shortage of easily extractable gold in Brazil.
- Easy access for Brazilians to be established in Suriname.
- High gold grade of surface ore.
- Extensive highly prospective areas in the Surinamese greenstone belt.

The lack of infrastructure to reach the richest goldfields in the interior is the main obstacle for a gold rush of major proportions in Suriname. The lack of water for irrigation and mining is another serious problem. It is appropriate to examine alternatives to build channels using water from the Brokopondo (artificial) Lake. There is no need for pumping, as water can flow by gravity through the Brokopondo/Nieuw Koffiekamp areas. The need for assistance in Suriname is urgent and the main point is the establishment of a present and active mining department (Mineral Institute) which can control the mineral titles as well as the exploration and mining activities in the interior. The presence of foreign artisanal miners is changing the subsistence characteristic of mining practiced by Surinamese villagers. The Governmental control of mining activities is completely dismantled. The Geological Mining Services is not a shadow of its past of services to the community. The idea of forming a new Mining Institute to look after the mining sector in Suriname is adequate as long as

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<sup>19</sup> Davidson, J. (1997). Partnering with Village Based Miners on Las Cristinas. Paper presented at Expert Group Meeting on Mercury Abatement and Small-Scale Gold Mining. UNIDO, Vienna, July 1-3. 5p.

financial and human resources can be provided. The idea of implementing a Foundation of Experimental Mining is extremely opportune. However the Mineral Institute must show its competence in structuring itself before organizing the artisanal mining sector.

UNIDO must follow up the next steps of the organization of the Surinamese mining and the environmental sectors. The social and cultural aspects of the population in the interior are far more complicated than it seems at the first glance. The Maroon communities have specific cultural characteristics that cannot be ignored in any project. They are also suspicious of any Government action in the interior. A project to establish a Foundation of Experimental Mining can be a lost shot in the middle of the chaotic and complex situation that is currently the Suriname mining sector. Commitment of Government and miners with the Foundation is mandatory. UNIDO must see signals of this commitment before implementing any project in Suriname.

Vancouver December 15, 1997

A handwritten signature in black ink, appearing to read 'm. veiga', with a horizontal line extending to the right from the end of the signature.

Marcello M. Veiga

Certified Brazilian metallurgical engineer, CREA 36806, Rio de Janeiro

**MARCELLO MARIZ DA VEIGA***Professional Experience*

1998	Assistant professor of the Department of Mining and Mineral Process Engineering of the University of British Columbia (UBC), Vancouver. Teaching Mining and Environment.
1997	Assistant Professor of UBC. Consultant for UNIDO, for artisanal gold mining activities and mercury contamination in Suriname and Guyana. Member of the consulting team of Round Table Group, Inc., Chicago
1996	moved to Vancouver. Adjunct professor of UBC. Consultant for UNIDO, for mercury contamination in Latin America as well working as a consultant for Canadian mining companies.
1995	Director of Madison do Brasil S.A. (currently Ourominas) also consultant for UNIDO-United Nations Industrial Development Organization, for issues related with mercury problems caused by artisanal gold miners in Venezuela.
1994	received his PhD from Department of Mining and Mineral Process Engineering of the University of British Columbia.
1992	joined Univ. British Columbia as a visiting researcher to apply Artificial Intelligence tools to Environmental Sciences.
1990-92	worked in Vancouver as consultant for Enerconsult Engenharia S.A. in two projects.
1989	worked for 6 months as consultant to the Pocone Project set up by CETEM and the Brazilian Congress to investigate the effects of Hg discharged by gold mining operations in the Ecological Park of Pantanal, Brazil.
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.
1984	contracted by Companhia Vale do Rio Doce, the main mining company in Latin America, to work in the exploration branch as a technical advisor to the Geology Directorship. The work comprised use of concepts of Applied Mineralogy to evaluate ore deposits.
1984	invited to participate in the laterite group of Dr. W.S. Fyfe as a visiting researcher at the University of Western Ontario, Dept. Geology.
1984	received the M.Sc. degree in Environmental Geochemistry from the Federal University Fluminense in Rio de Janeiro, Brazil. M.Sc. Thesis: Geochemical properties of the copper-hydrous ferric oxides binding, Salobo, Carajas.
1979	work at the Salobo Project, a copper deposit located in the Amazon; studies on the weathered copper ore: mineralogy, beneficiation and hydrometallurgy
1978	contracted as engineer at the Centre of Mineral Technology (CETEM) in Rio de Janeiro, to conduct studies on applied mineralogy, providing analytical support to ore processing and hydrometallurgy projects.
1977	received his degree in Metallurgical Engineering from the Catholic University of Rio de Janeiro, Brazil.

*Appendix 1 - Project Proposal*

**THE FOUNDATION  
FOR EXPERIMENTAL MINING**

Prepared by

**Christopher Healy**

OAS, Organization of American States Special Mission to Suriname

**Marcello M. Veiga**

Consultant for UNIDO, United Nations Industrial Development Organization

Paramaribo, Suriname

November 1997

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## A. SUMMARY OF THE PROJECT

### 1. **Name of the project**

Foundation for Experimental Mining (FEM)

### 2. **Objectives**

To establish the *Foundation for Experimental Mining* (FEM), under the supervision of the GMD/Minerals Institute, which will have a special cooperative relationship with this institution. The main objective of the foundation is to establish *experimental mining centers* (EMC) in the interior of Suriname, in order to provide training and assistance to artisanal gold miners, and thus contribute to the transformation of artisanal mining from an unstructured, illegal activity to a legal, ecologically sound and viable employment opportunity for the people of the interior.

Each EMC will have three units: a training unit, an operations unit, and a support unit. The training unit will develop course material and conduct training sessions, the operations unit will establish and maintain training facilities, while the support unit will provide more general assistance to the artisanal miners and their families.

### 4. **The Main Project Context**

1. A Cooperative Agreement must be concluded between the Ministry of Natural Resources, the GMD/Minerals Institute, and an international organization able and willing to provide the newest technology available for abatement of mercury pollution and the appropriate technology for artisanal operations, and other technical support.<sup>20</sup> This organization will be primarily responsible for developing the operations unit.
2. Support and funding by an international organization, which will assist and provide funding for the development of the training material, and support the training sessions. Extensive experience and expertise on the interior is mandatory.<sup>21</sup>
3. Support and funding by an international organization and one or more local organizations with experience and expertise on the interior, are required. These organizations should be willing and able to assist in the development of the support unit. This task has a major medical and occupational health component, as well as a strong social component.

### 5. **Implementing Agencies**

The FEM, with technical assistance from the GMD/Minerals Institute and the international and national organizations to be selected.

### 6. **The Costs of the Project**

An initial investment of US \$ 300,000 will be required to establish the foundation and operate the first training site.

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<sup>20</sup> UNIDO has the expertise.

<sup>21</sup> The OAS Special Mission is qualified to perform these tasks.

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**7. Sources of Financing**

Donors to be selected

**8. Duration of the Project**

Two years

**B. THE PROJECT PROPOSAL****1. Background information**

There is an urgent need for immediate action in the interior of Suriname. The recent boom in artisanal gold mining is the major source of environmental destruction in the interior of Suriname. The lack of concern on the part of the miners, and their poor knowledge of efficient gold-extraction methods, lead to increasing emission of mercury into the environment.

Woman and children who rely heavily on river fish for meeting their protein needs are becoming victims of pollution caused by their fathers and brothers. Siltation caused by the misuse of hydraulic monitors is choking out plant life, causing a significant reduction of the total aquatic life, including the much appreciated *kumalu* fish, which thrives on aquatic plants in the rapids. Most threatened by artisanal mining, however, are the miners themselves. They are exposed to mercury vapors and other serious occupational hazards.

These threats are not limited to the interior. Over a hundred jewelry shops in the capital regularly buy gold. During the purchasing process, the gold offered for sale is torched, releasing the residual mercury, which usually accounts for about 3 to 5 % of the weight. This represent a serious health hazard to the urban population. Moreover, considerably portion of the fish being sold in the capital city originates from the upper-Suriname river and other interior locations, bringing home the mercury pollution which is considered a problem of the interior.

About 8000<sup>22</sup> artisanal miners are toiling in the interior today, and this number is increasing rapidly (see map on page 10). At least 8 tons of gold are produced per annum, and an equal amount of mercury is being dispersed in the rainforest.

Why this sudden increase in gold mining? Both national and regional factors play a role. Some of these are listed below:

- The economic isolation which existed during the interior conflict (1986-1992), forced the population to mine gold in order to be able to purchase food and supplies with hard currency in neighboring French Guiana;
- the serious economic downturn accompanied by high inflation (1986-1994) and the resulting shortages of foreign currency (see graph on page 11);
- the lack of employment opportunity for thousands of uneducated men and women of the interior who were unable to attend the local schools shut down by the interior conflict;

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<sup>22</sup>

This is a conservative estimate. The actual number may be as high as 15,000.

- the high cost of living in the interior. Gold is the only commodity available which gives interior residents immediate access to hard currency needed to finance such essential equipment as chain saws, generators and outboard motors;
- the dwindling reserves of easily extractable gold in neighboring Brazil, population migration caused by shortages of land in certain regions, absence of entry restrictions and the attractive price being offered for gold in Suriname;
- the steady increase in the average price of gold during the period 1973-1996;
- the lack of controls in the interior Suriname.

The past decade witnessed a shift from permanently settled miners working in their original area of residence, to migratory miners coming from the coastal area and Brazil. The migratory miners tend not to settle permanently in the regions they work, but move from location to location, lured by stories of rich deposits elsewhere. Such a migratory labor pattern does not encourage the establishment of stable and permanent settlements, which could contribute to the development of the interior. Moreover, this pattern has caused environmental damage at locations which are widely dispersed, making remedial action more difficult and costly.

Why promote legal and structured artisanal mining? First of all, artisanal miners tend to concentrate on alluvial and weathered ores, which usually have an erratic distribution of gold, and are thus expensive to survey and not attractive to most major mining companies. Trained artisanal miners, on the other hand, are extremely successful in locating and exploiting viable ore bodies. In the Amazon artisanal miners discovered over 2,000 mine sites. In addition, artisanal mining has low entry barriers, which is ideal for the poor and uneducated persons of the interior, who lack the skills and capital resources to start larger companies.

Because it is labor intensive, the sector has a high employment potential. The artisanal mining sector can help stem the tide of urban migration. During the past three decades almost half the interior population migrated to Paramaribo and the coastal area, a factor which resulted in overcrowded poor neighborhoods in the outskirts of Paramaribo. Today the jails are full with young men from the interior, victims of their lack of preparation to deal with the competitive market economy and social conditions in the city.

And finally, the recent decline in the gold price, will make render many deposits unattractive for capital intensive mining in a conventional manner. Many companies have abandoned small projects, where the perspective for finding a major deposit has not been indicated. This will create opportunities for small operators employing creative and organized mining procedures. The Government, which receives little or no revenues from illegal mining now taking place, could benefit from the growth of small formalized and structured operators. These operators are more likely to comply with the law and pay the required dues.

## 2. Objectives

To establish the *Foundation for Experimental Mining* (FEM), under the supervision of the GMD/Minerals Institute. This foundation will have a special cooperative relationship with the GMD/Minerals Institute. The main objective of the foundation is to establish *Experimental Mining Centers* (EMC) in the interior of Suriname, in order to provide training and assistance to artisanal gold miners, and thus contribute to the transformation of artisanal mining from an

unstructured, illegal activity to a legal, ecologically sound and viable employment opportunity for the people of the interior.

### 3. Constraints

The success of the project will depend on a number of factors, including, but not limited to, the following:

- A firm commitment by the Ministry of Natural Resources, the GMD and the soon to be established Minerals Institute to support the project. For example, since training will be conducted under realistic conditions, the viability of the project will require a number of gold mining concessions, which must be made available by the Ministry of Natural Resources and the GMD.
- A firm commitment on the part of the traditional rulers, the local population and the artisanal miners. These institutions and persons must agree to fully support the project, as they will be participants in the activities, and beneficiaries of the results.
- A firm commitment by the private sector to hire trained miners when job opportunities arise, since not all miners will be self-employed.
- Support by the local Government and authorities in helping establish the EMCs.
- Cooperation and support by the NIMOS, the institute which is ultimately responsible for environmental monitoring in Suriname.
- Cooperation between the FEM and the University of Suriname could create opportunities for university lecturers and students to become familiar with the activities being developed at the EMCs, and in time the university could develop specific technology and expertise which would be of invaluable assistance to the program. The University could then provide analytical services and assist in environmental monitoring programs.

### 4. The project

- a. *The beneficiaries*: artisanal miners, the population of the interior, and the Government of the Republic of Suriname.
- b. *Results*: By establishing and operating EMCs, the FEM will create the following benefits for the communities of artisanal miners and the inhabitants of the interior, as well as for the Government:
  - improved mining and mineral process techniques
  - more efficient gold production
  - improved occupational hygiene of miners
  - reduction of the environmental impacts caused by disorganized mining, and specifically a drastic reduction of the use of mercury and its emission
  - legalization of mining activities
  - improved access to artisanal miners to funds for project financing and development

- improved access to medical and other social services for miners and their families
- an organized artisanal mining community
- reduction of illegal gold purchase, and reduction of crime rates

## 5. Method

The FEM will establish one or more EMCs. Each EMC will consist of three units: training, operations, and miners support (see organizational chart on page 12). Through these centers, the foundation will provide the following services to artisanal miners:

*Training unit:* training will be offered to artisanal miners in order to enhance their technical and economic skills. The technical training will include modules on:

- exploration and ore estimation
- mining methods
- ore processing
- amalgamation
- waste management
- reclamation and revegetation.

In addition, other skills required to survive as small business will be taught:

- elementary bookkeeping
- project planning, development and financing
- health and hygiene
- social, organization and leadership skills

All training will be conducted under realistic conditions on actual mine sites. The trainers will generate a series of educational materials consisting of brochures, booklets, hands-out, cartoons, videos, songs, etc.

*Operations Unit:* As noted, all training will be conducted under realistic conditions at actual mine sites. The operations unit will be responsible for establishing and maintaining these training mines. While being trained, miners will employ simple semi-mechanized mining and mineral process techniques in a mining concession owned by FEM, under supervision of the trainers and an operations manager. The following main tasks are envisioned for this unit:

- EMC development and operations
- securing new and appropriate mining technology
- maintaining the training premises, equipment and supplies
- operate the training mines
- develop and operate amalgamation centers
- facilitate the gold purchase
- environmental security and monitoring

While the training is being conducted, actual gold will be produced. This gold will be sold, and the income used to help finance the training program. The operations manager will be

responsible for ensuring that training mines are managed in a responsible manner, and that good and efficient mining practices are observed. This is an essential aspect of establishing credibility among the students.

Once established and operating, the EMCs can offer services in addition to training. One such service would be the controlled amalgamation by trained operators of concentrates brought to the EMC by miners working in the area. Under this procedure, the indiscriminate use of mercury and the resulting pollution can be prevented. The Centers will produce melted bullion which will be sold to a representative of the Central Bank who will be stationed at the Centers.

*Support Unit:* to improve the economic and social welfare and well-being of artisanal miners and their families, this FEM unit will provide a type of assistance not offered by the other two units. This assistance will include:

- support for miners in organizing themselves
- project planning, development, and financing
- occupational safety and health
- legal advice and support
- establishing funds (investment fund, social fund, etc.)
- miner counseling
- family health and welfare (focus on women and children)
- community relations

Helping the miners organize themselves will be an important aspect of the structuring process. This institutional support is an essential component to assist organized miners in formalizing, legalizing and incorporating artisanal mining into the national economy. Moreover, until the miners are organized, it will be very difficult to initiate systematic efforts aimed at mitigating unnecessary pollution and other destructive mining habits.

Many trained miners will want to develop their own operations, and will need support in planning, development and financing. In order to be able to help miners finance these effort, they should be encouraged to establish saving funds for this purpose. Legal support will also be an essential component of helping miners secure legal titles.

Special attention needs to be paid to women and children. Women will be assisted in organizing themselves. Support will also be provided for helping them in their traditional economic activities, such as agriculture, fishing and other subsistence tasks. Miner families should be encouraged to save money and to use these resources to begin to develop alternative economic opportunities, when the ore bodies are depleted.

Existing organizations will be contacted and asked to assist in providing information to miners and their families on the prevention of common tropical diseases such as malaria and lechmaniosis. Special attention will be paid to mine safety and occupational health.

FEM personnel must develop good relations with the local communities and their leaders. Special attention must be paid to the claims made by local communities to tracks of land to be used by the FEM for training sites. If necessary, cooperative agreements will be ironed out with communities located near the training sites in an effort to avoid conflicts. If desired, the FEM

will assist such communities in establishing viable mechanisms and instruments aimed at community development.

*Site selection.* The following selection criteria for establishing EMCs will be utilized.

- means/cost of access (land, water, air)
- number of miners active in the area
- dispersal of miners
- available infrastructure
- availability of concessions
- security
- health risks

The attached map (appendix 3) lists ten zones in order of accessibility. Most of zone 1 can be accessed by car, while zone 10 can only be accessed by boat and by air. Since zone 1 is easiest to access, it will be cheaper too operate an EMC in this area. A reasonable number of miners is active in zone 1, but they are somewhat dispersed. This area covers almost 2000 km<sup>2</sup>, and there are about 1250 miners active in zone 1. An advantage of zone 1 is the available infrastructure. The District Commissioner of Brokopondo indicated that he would be willing to make available a dwelling to the FEM. Moreover, the GMD has reserved a concession for the FEM across the river from the Government administrative center in the district of Brokopondo. A police unit is stationed there, and the risk of malaria is much lower than in south-eastern Suriname. It is recommended, therefore, that the first EMC be established at the Brokopondo administrative center. When the necessary experience and expertise is developed, the FEM could expand its activities further to the South and into more remote and expensive locations.

## **6. Organization and Management**

The board of the FEM will be responsible for the overall coordination of the project. The board will hire a management team to develop and operate the EMCs, and to conduct the training sessions. The GMD/Minerals Institute will make available qualified staff members and provide other assistance in making the EMCs operational. A special agreement, which needs to be approved by the Minister of Natural Resources, will be required to make possible the regular and committed manpower assistance by the GMD/Minerals Institute, to the FEM.

## **7. Reporting and evaluation**

The FEM will be a foundation. The statutes will require that an annual report must be prepared and published. Moreover, each EMC will prepare a separate account of each unit and other general activities it carried out, including a statement of income and expenditures.

## **8. Procedures**

The proposal will be presented to the Minister of Natural Resources for consideration and approval. The GMD/Minerals Institute will play an important role in creating the FEM. Extensive talks will be held with all beneficiaries, relevant parties and organizations interested in contributing to the project.

**Appendix 2 - Foundation of Experimental Mining (Organization Chart)**

