



**VISIT TO BRAZIL  
BRAZILIAN MINING SECTOR REGULATORS  
AND MINE SITE OPERATIONS  
MARCH 18 – 26, 2000**

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## **EXECUTIVE SUMMARY**

A one-week field trip by Guyanese officials from Guyana Geology and Mines Commission (GGMC), Guyana Gold and Diamond Miners' Association (GGDMA), to Brazil was sponsored and facilitated by the CIDA Guyana Environmental Capacity Development (Mining) Project (GENCAPD). The group left Guyana on Saturday, March 18, 2000 and returned Sunday, March 26.

Participants were:

From GGMC, Karen Livan, Manager, Environmental Division, Derek Babb, Senior Mining Engineer, Mines Division, and Mahendra Samaroo, Mining Engineer, Environmental Division; Malcolm Sears representing GGDMA and Jean-Marc Barbera, GENCAPD Field Manager. Acting as facilitator, Diane Lorenzato, International Relations Manager of Canada Centre for Minerals and Energy Technology, CANMET, ensured appropriate linkages with Brazilian government officials. The program for the visit was organized by CETEM, The Brazilian National Centre for Minerals Technology. CANMET and CETEM have been collaborating for over five years.

The group met with officials from different governmental institutions, viz – CETEM; Brazilian Geological Survey, CPRM; National Department for Mineral Production, DNPM; Ministry of the Environment, MMA; and Ministry of Mines and Energy, MME, and toured two regions with small-scale quarry and mining operations for dimension stones and gold. The objective of the trip was to learn how the Government of Brazil is organized to deal with the Minerals and Metals sector, with an emphasis on small-scale mining operations. The visit was also aimed at identifying possible areas for technical exchange between Guyana and Brazil, and determining if Brazilian environmental protection technologies were readily adaptable to the Guyanese context.

Discussions and interchange with various government officials focused on existing regulations, the development and enforcement of regulations, environmental management and rights of indigenous communities. The group received supplementary information in the form of technical publications and brochures, to provide added detail and clarity on several of the topics discussed.

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## 1.0 INTRODUCTION

The Guyana Environmental Capacity Development (GENCAPD) Mining Project, one of the project's main objective is the building of environmental management capacity in the mining sector through training exposure and environmental systems development, sponsored and hosted a one-week field trip to Brazil from March 18 – 26, 2000.

The field tour and program was organized by CETEM (Brazilian Center for Mineral Technology), with which the Canada Centre for Mineral and Energy Technology (CANMET) has been collaborating with for more than five years.

The Guyanese delegation consisted of officials from Guyana Geology and Mines Commission (GGMC): Karen Livan, Manager, Environmental Division, Derek Babb, Senior Mining Engineer, Mines Division, and Mahendra Samaroo, Mining Engineer, Environmental Division; from Guyana Gold and Diamond Miners' Association (GGDMA): Malcolm Sears and from GENCAPD project, Jean-Marc Barbera, Field Manager. Acting as facilitator, Diane Lorenzato, International Relations Manager of Canada Centre for Minerals and Energy Technology, CANMET, ensured appropriate linkages with Brazilian government officials.

The objectives of the trip were threefold: 1) to examine the Brazilian Governments' organizational structure in the mineral and metals sector, with emphasis on small-scale mining operations; 2) to identify possible areas for technological exchange between Brazil and Guyana; and 3) to determine if Brazilian environmental technologies were readily adaptable to conditions in Guyana.

Throughout the week, the delegation met with several different governmental organizations, including: Center for Minerals Technology (CETEM), Geological Surveys of Brazil (CPRM), National Department of Mineral Production (DNPM), Ministry of Mines and Energy (MME) and the Ministry of the Environment (MMA). The group also toured small-scale mining and quarry operations for gold and dimensional stone in two regions of Brazil (Santo Antonio do Padua and Poconé).

Through discussions with various government officials on topics such as regulations, regulatory development and indigenous rights, the delegation was able to gain a thorough appreciation of mining practices and regulations employed in Brazil. Further dialogue and exchange with Brazil will be encouraged through the Ministry of Foreign Affairs in Guyana.

This report made by the group presents on a daily basis a summary of the visits done and the associated comments in Brazil. A general conclusion made by the group finalizes the report. In appendices, copies of overhead presentation made by CETEM and CPRM, a series of photos and a contact list have been included.

## **2.0 SITE VISIT AND COMMENTS**

### **2.1 Rio de Janeiro**

**SUNDAY, MARCH 19**

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#### **BEGINNING OF THE TRIP**

The Guyanese group arrived in Rio de Janeiro, and was met by Mr. Paulo Sergio Soares, Senior Engineer of CETEM, Brazilian National Center for Minerals Technology.

**MONDAY, MARCH 20 – RIO DE JANEIRO**

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#### **VISIT TO CETEM**

Meeting at CETEM from 10:00 to 15:30

Mr. Celso Santos, Advisor to the Director, welcomed the group. Several technical presentations were made to showcase the collaborative work that CETEM has been doing with small-scale miners and garimpeiros, and studies conducted on the fate and effects of mercury used in gold mining (Photo 1 and 2).

The presentation of Carlos Peiter, Head of the multi-disciplinary Policy, Legal and Environmental Studies Department, focused on building relationships between mining companies and the communities through consensus, and building relationships between mine operators and the government. CETEM has been involved in promoting a consensual and multi-stakeholder approach between mining companies and communities, in order to plan for the future and ensure sustainability of the community once mining activities have come to an end. CETEM has created a network among Federal, Provincial (State) and Municipal government levels to work with community representatives and miners to develop a plan for the municipality and region that will take cognizance of the social and economic aspects of mining. The goal of this plan is to make miners sustainable by making the communities sustainable.

In addition to planning for sustainability for the future, CETEM provides technical direction and advice to small scale miners currently involved in dimension stone production to promote economic viability in the sector. To this end, CETEM is involved in a project for the extraction and production of dimension stone, through which small-scale miners are encouraged to form cooperatives. Pooling of resources in cooperatives is intended to help them maintain their livelihood in the long term. CETEM also provides technical advice to small-scale operators to make them more efficient and to improve their environmental practices.

Dr. Adao Benvindo da Luz, Mining Engineer, Head of the Mineral Processing Department, made a presentation on garimpeiros (small-scale gold miners). He indicated that due to low gold prices and high fuel prices, gold production from the garimpeiros has decreased significantly since 1998, when garimpeiros accounted for 32% of all gold production. Efforts to introduce a cooperative approach among the garimpeiros within the last thirty years have been unsuccessful since gold operators do not trust each other with their high valued gold. Gold placer mining practices in Brazil are very similar to those applied in Guyana, with the important exception that

Brazilian operators use mercury in their sluice boxes. The main methods used in Brazil are hydraulicking and sluicing, using sluices on the ground, or raised sluices. Suction dredging is done in the Madeira River in Rondonia. Retorts are used to recover the gold from the amalgam. An underground garimpeiro operation proved to be unsustainable due to a lack of exploration: such an operation employing exploration would be considered to be a company operation rather than a garimpeiro-type operation.

To assist the garimpeiros, CETEM has developed technology to use mercury in a closed circuit to reduce the environmental impact. CETEM has also developed a retort and an amalgamation drum (in which water is used to avoid much volatilization of mercury).

Dr. Luis Gonzaga Santos Sobral, Chemical Engineer, Hydrometallurgy Department, Environment Technology program, spoke about the use of mercury to recover gold. *Dr. Sobral affirmed that it is very difficult to replace mercury in the recovery of gold because of the simplicity and effectiveness of the technique.* However, since the toxicity of mercury is an important health consideration, an understanding of mercury toxicity is important for devising methods to reduce the impact on human health. CETEM has undertaken considerable research on the fate and effects of mercury, and has been involved in providing basic education to miners about mercury. In educating miners about the health effects of mercury use, the Brazilian authorities focus on reducing the amount of mercury that is released to the atmosphere. CETEM, in its study “Preliminary Diagnosis of the Environmental Impacts caused by Gold Prospecting in Alta Floresta/MT - A case study” by Luiz Henrique Farid *et al.* (1992), calculated that 70 to 75% of mercury lost to the environment is by open burning of the amalgam, 20 to 25% being lost with the amalgam tailings, and the residual 0.5 to 5% in the gold burning shops. Publications by CETEM for miners, on the effects of mercury, could be used in the production of material for Guyanese miners.

CETEM demonstrated that a significant fraction of gold is lost in the amalgamation tailings that are discarded in the environment and the results of this demonstration are used to encourage small miners to adopt new practices. CETEM developed an electro-leaching (electro-oxidation) process for the recovery of mercury from amalgamation tailings while also recovering residual gold. Pilot scale tests are underway at two pilot plants. (Thoming, Sobral and Wilken, 1999, in their publication ‘Mercury Contaminated Sites: Risk, Characterization, Assessment and Remediation’ reported that though experimentally it was possible to reduce mercury concentration in amalgamation tailings to less than 1ppm, this is not always low enough to be considered as suitable for discharge. Farid *et al.* (1992) reports that in gold operations in Alta Floresta, amalgamated tailings contain 5 to 134ppm Hg.)

CETEM showed that the typical retort recovers 15–20% of gold with the mercury, because of the high temperature applied. Temperature must be properly controlled and raised slowly to reduce gold losses, since at high temperatures mercury volatilizes rapidly and ‘drags’ gold into the retort. Two to 3% of the mercury typically remains in the condenser of the retort, and temperatures of 1000 to 1100°C are needed to remove all of the mercury.

From 1989-1992, Dr. Saulo Rodrigues Filho, Environmental Geochemist in the Mineral Processing Department, was involved in the assessment of mercury pollution in the Pocone Region in the south of Mato Grosso State, where garimpeiros are active. As part of a multi-disciplinary project with geological, biological, geochemical, sociological, mining engineering

and mineral processing inputs, samples were taken up to 30 km away from the mining activity to monitor the concentrations of mercury and heavy metals - Cu, Pb, Zn, Mn and Fe - in water and soil. This project was consequent upon the broad based approach adopted by CETEM to carry out studies for appraising and diagnosing the environmental impact caused by mining and metallurgical activities.

Resulting maps of the region showing different levels of heavy metal and mercury concentration indicate higher levels of mercury near gold mining activities, due to low mobility of metallic mercury in water. The maps also demonstrate the effects of river transport and deposition of sediment on the concentration of mercury and heavy metals, since higher concentrations of mercury were also found where stream velocities decreased abruptly, and suspended sediments settled out.

In 1991, a second interdisciplinary study was undertaken in Alta Floresta in northern Mato Grosso State. The distribution of mercury in soil was found to be influenced by the prevailing wind direction, and the highest concentrations occurred near gold buying shops. Metallic mercury is not very mobile in water, but when vaporized as occurs in the open burning of amalgam, it oxidizes readily and becomes bio-available in water. Open burning of amalgam and gold buying shops therefore present a threefold risk to human health and the environment, from mercury inhalation, and from oxidized mercury vapour in soil, and bio-available in water.

Dr. Ricardo Melamed, Environmental Geochemist within the Mineral Processing Department has extensively researched the mobility and stabilization of hazardous elements, including mercury, and mercury speciation. Significant findings are - mercury stabilizes under high pH conditions and is very mobile in low pH environments; organic mercury is more mobile than inorganic mercury; the mobility of mercury increases in the presence of chloride ions; the presence of phosphate enhances the adsorption of inorganic (oxidized) mercury; and, organic acids (fulvic and humic) promote the accumulation of mercury in living organisms, causing bio-magnification in dark waters.

There was some initial difficulty in analyzing organic mercury, and poor results were obtained. CETEM benefited from Japanese technical assistance in setting up a new laboratory for analysis of low levels of mercury, and staff members are presently being trained to analyze samples. Collaborative research has been done with universities to use aquatic plants to absorb heavy metals, and this has implications for treating heavy metals contamination from industrial processes, including gold mining.

Since CETEM has developed considerable expertise and experience in the application of technologies to improve gold recovery in small-scale gold mining, and related mercury issues, GGMC and GGDMA could benefit from technical collaboration with this institution. GGMC is finalizing a proposal for submission to the Brazilian Agency for Cooperation, ABC, for funding for GGMC staff members to be trained at CETEM in mercury analysis and assessment of mercury in the environment, and for experts from CETEM to work in Guyana in establishing a protocol for the sampling and analysis of mercury.

In the afternoon the delegation toured CETEM's laboratories (Photo 3). Dr. Sobral discussed the physical chemistry of the amalgamation and retorting processes and the implications for the granulometry of gold particles recovered after retorting. He disclosed that CETEM is pleased

with the results of ongoing collaborative research with Canadian mining companies to find an alternative to cyanide use for gold recovery. The team then traveled by road to Santo Antonio de Padua to visit small-scale dimension stone quarries. CETEM representatives, Carlos Peiter, Head of the Department of Policy, Legal and Environmental Studies, and Adriano Caranassios, Mining Engineer within the department, accompanied the team to explain the processes used in the extraction and production of dimension stone, and to indicate how the cooperative approach was developed.

## **2.2 Santo Antonio De Padua, Rio de Janeiro State**

### **TUESDAY, MARCH 21 – SANTO ANTONIO DE PADUA, DIMENSION STONE QUARRIES**

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#### **GENERAL**

There are about 4000 small-scale miners working in the region, and the strategy of the government is to help the operators to stay in business and run profitable operations in order to stimulate the local economy. In addition, government wishes to ensure that operators will remain in business and have sufficient funds available to rehabilitate the site once individual operations come to an end. Submission of an Environmental Management Plan is a prerequisite for the issuance of a Quarry Licence. The company or operator has ten months to develop and submit a plan.

In order to facilitate the development of dimension stone by small to medium scale operators, CETEM and the Geology Division of the University of Rio de Janeiro are undertaking an extensive geological survey of that region. CETEM is considering preparing a feasibility study with Government funding that will support applications for loans by operators. The plan is that several quarries will supply a common plant. This will support networking of operators for technical assistance, and the application of a common strategy.

A network of technical assistance for quarry owners was established, comprising approximately 40 Brazilian institutions, such as various universities, banks, workers' unions, producers' associations, State and Federal Government Agencies, Federal University of Rio, Brazilian Geological Survey CPRM, CETEM, DNPM, Rio State Environmental Agency, Federal Environmental Agency, Ministry of Labour, State Government and Rio Chamber of Commerce. This network will provide a forum for discussing problems and challenges relating to dimension stone production, and for devising strategies for longer-term development of the region to achieve economic, social and environmental sustainability.

#### **VISIT TO THE LUIS MACIF QUARRY**

There are 25 people employed in the quarry of which only 5 are full time employees, mainly the equipment operators. The other 20 are paid on the basis of their production. Capital investment has been focused on the acquisition of the *'fire saw'*; a high-pressure torch used to extract the stone. The *'fire saw'* facilitates the production of large cubic blocks of roughly 0.5 metre by 0.5 metre by 0.5 metre dimensions, which are then reduced by hand chiseling.

Closed circuit treatment of water, recommended by CETEM, was not adopted since the company said that it was expensive.

Health and safety issues were evident, and enforcement of regulations is reportedly difficult and ineffective, since the operators are willing to pay a fine and return to *'business as usual'*. Even the draconian measures employed by the regulators who shut down the quarries and had 500 persons put in prison were not effective. The quarries were re-opened with conditionalities, but enforcement continues to be poor. By agreement between the State Mining Agency and the provincial Environmental Agency, enforcement is carried out by the Mining Agency.

#### **VISIT TO CARLOS AUGUSTO QUARRY**

25 persons are employed, eight full-time, whereas a year ago there were 30 to 40 employees. Explosives are used to extract the stone, and capital has been invested to purchase equipment to remove the topsoil and to cut the rock. The company exports its products to Canada and the United States through a broker in Belo Horizonte (Photo 4).

#### **VISIT TO PIEDRAS PARAISO COOPERATIVE**

This cooperative of five small-scale operators deals mainly with cutting of rock into final products, and marketing. The operators joined to purchase mechanical equipment to cut the rock and to organize the marketing of their products. Mechanical cutting of the rock has the advantage of reducing the waste material produced.

The team returned to Rio de Janeiro by road late in the afternoon.

### **2.3 Rio de Janeiro and Brasilia**

#### **WENESDAY, MARCH 22 – RIO DE JANEIRO AND BRASILIA**

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##### **VISIT TO CPRM IN RIO DE JANEIRO**

Mr. Gildo de A. Sa C. de Albuquerque, Mining Engineer with CETEM led the delegation to meet with representatives of the CPRM (Servico Geologico do Brasil), Mr. Samir Nahass, Chief Advisor for International Affairs, Mr. Sabino Orlando Loguercio, Head of the Geology Department, and Dr. Schulz, Geologist. Dr. Schulz visited GGMC in 1999 as part of an interdisciplinary team from the Brazilian Cooperation Agency (ABC) on a mission to define proposals for technical cooperation between Guyana and Brazil (Photo 5).

The purpose of the meeting was to gain an understanding of the administrative structure, services and main activities of CPRM, and to establish linkages between CPRM and GGMC. The organizational chart and the overheads used for Mr. Nahass' presentation were provided and are attached in the annexes.

In 2000, CPRM will undergo a downsizing exercise to reduce the staff by 30%. This will be done through attrition and pre-retirement packages. GGDMA representative, Mr. Malcolm Sears suggested that a lot of expertise will be available to Guyana through these retired geologists and experts.

A major mapping program has been set up to map the Amazon region, which represents 60% of Brazilian territory. The program is soon to be initiated with aeromagnetic surveys and gamma spectrometry. It is proposed to complete 700,000-line km of gamma spectrometry and

aeromagnetic surveys over the next three years, 2000 to 2002, at one km line spacing in areas where there are no previous data, and 500m spacing in areas with geological data. Field campaigns at an estimated cost of \$US 10 per km, to produce profiles across main rivers and cross sections of the region, will complement the airborne geophysical surveys and integrate remote sensing and geochemical data. The purpose of the program is to encourage mining activities in this region by producing geological maps at scales of 1:250,000 and 1:100,000, and providing the means for the determination of specific exploration targets. The information will be released on the Internet to the public as soon as it is available.

CPRM has several international agreements with Canada, Cuba, Mercursor countries, and French Guiana. CPRM is surveying the area close to the border with French Guiana to produce geological maps.

### **WRAP-UP MEETING AT CETEM**

The delegation returned to CETEM to conclude discussions with Dr. Sobral on the subjects of mercury retort technology and the electro-oxidation batch system applied by CETEM at two pilot plants, for the clean up of mercury (Photo 6).

At 16:00 hrs, the delegation left for Brasilia.

## **2.4 Brasilia**

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### **THURSDAY, MARCH 23 – BRASILIA**

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#### **DELEGATION LEADING**

Mr. Gildo de A. Sa C. de Alburquerque, Mining Engineer with CETEM again led the delegation, this time to Brasilia to meet with senior government representatives of various organizations.

#### **VISIT TO DNPM**

A meeting with Dr. Joao R. Pimentel, Director General, DNPM (National Department of Mineral Production) and Osvaldo Barbosa Ferreira Filho, Assistant Director General, provided the following details on DNPM, which, like GGMC, has responsibility for administration and regulation of mining titles and mineral production in Brazil (Photo 7).

DNPM is responsible for the mineral cadaster and mining titles for Brazil. There are more than 400,000 titles in the database of which 50,000 are for the exploration phase and 13,000 for operations. The mining title system is totally automated which speeds up the process. As an example, 89 titles have been issued in one day for one district. By next September, all the different districts will be fully automated and will be able to issue titles within two days. This new process is very efficient and is replacing an old one in which issuing a title could take up to 30 years. Since the adoption of the automated system, 9557 titles have been issues in 2 and a half months in year 2000 while in 1999, 3,700 were issued for the entire year. In Brazil, there are 40 million hectares available to the investors. A guide has been prepared for the investors to explain the rules that apply to mining in Brazil. Brazilian terms and conditions are similar to those applicable in other South American countries. A CD-ROM is available in addition to information on the internet at the DNPM.GOV. BR website.

There are five different types of mining titles or licenses in Brazil.

The first is the traditional one applied to all minerals - Claims and Licences. The mineral sought determines the area of a Claim – a gold Claim is 1000 hectares, but in the Amazon region a gold Claim can be up to 10,000 hectares. The normal time frame given to complete exploration is 2-3 years. In difficult circumstances, the time frame can be extended by 3 additional years. Before the end of the 3 years, the company must file an exploration report with DNPM. A one-year period is granted to prepare a feasibility study in order to apply for a Mining Licence. The Mining License is valid for the life expectancy of the mine. During the exploitation phase, one Real (80 cents US) per hectare per year must be paid to DNPM.

No environmental studies are required for the exploration phase. In order to receive the Licence for the mine installation, the company must receive a Licence from the State Environmental Agency. When this Licence is granted, DNPM can issue the Mining Licence, which is granted by the Minister of Energy and Mines on authorization of the President, who has delegated such authority. DNPM is responsible for reviewing the application and gathering the necessary information required to grant the Mining Licence. A Mining Licence is only granted to a company constituted under Brazilian laws, although the capital to be invested can be sourced from outside of Brazil.

There are more than 40 different taxes applicable to the mining sector. Some of the major applicable taxes are: Value Added Tax (VAT); Annual tax per hectare at the exploration phase, as discussed earlier; royalties at the production phase; and 13% income tax during the mining phase. There is presently a reform program to simplify mining taxation. A monthly royalty of up to 2% on the net smelter return is imposed by DNPM: it varies from 0.2% for precious stones, 1% for gold and 2% for other commodities. Royalty, calculated based on gross income minus cost of transportation, freight, insurance and other taxes, is considered to be compensation for permission for mining and extraction. Sixty-five percent of the royalties paid by the companies is returned to the community/municipality, to be used as they determine except for paying salaries and debt. Twenty-three percent is paid to the State Government and 12% to the Federal Government to be shared between DNPM and the Ministry of the Environment. DNPM is fully funded through revenues from exploration and mining activities.

Surface rights belong to the landowner, while subsurface rights belong to the State. When the Mining Company is not the landowner, there are different regimes governing surface and subsurface rights.

The second type of Licence is for exploration of industrial minerals such as clay, sand, gravel, limestone, or any construction material. This Licence is granted by the Municipal authorities on the discretion of the Mayor, and registered with DNPM for statistical purposes. The difficulty with this Licence is that operators may have to face changes imposed by an incoming Mayor.

The third type of Licence is granted to garimpeiros, individually or joined to form a Cooperative to exploit minerals. Cooperatives are encouraged, since they are easier to control/regulate, and as an incentive, they are given larger areas to work. Work is not limited to panning, and indeed can be sophisticated, with tunneling, etc. There is no need for an exploration phase. DNPM has identified districts/reserves for garimpeiro activity, and there are 25,000 Claims in Belem. There is flexibility to grant Licences in other areas on a case-by-case basis, but this is to be reviewed by

the government. Garimpeiros do not pay any revenues or fees to the government. A fee is actually paid by the first buyer, but this is difficult to control, resulting in skepticism on the part of the authorities as to what portion government actually receives.

It is difficult to control the environmental impact of garimpeiros, as well as health and safety factors of their operations. Very primitive instruments are used, unnecessary risks are taken, and many accidents are unreported. In addition, whereas government earns revenues from mining companies, garimpeiros make no payments to the State. One of the issues concerning the garimpeiro areas is that large mining companies are buying Licences from small-scale miners and mining without respecting any environmental practices. Another issue is that communities and politicians are ambivalent towards garimpeiro activities. Yet another issue is that unscrupulous persons sometimes exploit garimpeiros.

CETEM has been mandated to work with small-scale miners to improve their practices.

The fourth type of Licence is quite recent, and falls under a new law that was passed in 1999 and is being regulated from 2000. It can be issued to a municipal, state, or federal government-owned company for the extraction of minerals or materials for civil construction over an area restricted to 5 hectares. This regime was created in response to pressures from Mayors who wanted government to facilitate the extraction of materials required to build roads, etc. The Licence is issued by DNPM and it allows municipalities to access construction materials at a lower price than what the market offers. It also serves as a useful means of regulating pricing policies of the private sector. An environmental permit is prerequisite for the grant of the Licence, and royalties are paid to government. If the impact is restricted to the city, the municipality grants the environmental permit.

The fifth type of Licence covers dimension stone and civil construction minerals for the private sector. A Licence is granted for the exploration or exploitation phases. There is a special renewable Licence that is granted for a six-month period, which allows the company to position its product in the marketplace to ascertain the demand.

Mining aspects of mining activities in Brazil are regulated at the federal level. While environmental aspects have been delegated to the State agencies, there is also regulation at the federal level. There are no mining activities in lands of indigenous people. Since indigenous people's lands constitute 8.5 million km<sup>2</sup> or 12% of the Brazilian land area for 250,000 people, government is seeking to revise this policy. Hence, government is currently debating a law to authorize mining on indigenous people's lands on a case-by-case basis, with royalty being paid to the indigenous people concerned. The Mining Code of 1967 was revised in 1995. Additional revisions are underway to make Brazil more attractive to foreign investors.

### **VISIT TO THE MINISTRY OF MINES AND ENERGY**

The meeting was with Luciano de Freitas Borges, the Secretary, Secretariat of Mines and Metallurgy, Ministry of Mines and Energy. Mr. Borges led a Brazilian delegation to discuss the issue of Brazilian garimpeiros in Guyana with officials from the Ministry of Foreign Affairs in Georgetown, but the team did not meet with GGMC officials. He is a member of the board of Small Mining International (Photo 8).

The meeting with Mr. Borges focused on the vision of the government of Brazil for garimpeiros. He explained, as a background, that there are many different types of small-scale mining activities. Seventy percent of garimpeiro activities occur in the Amazon region, where mining is more intensive, and occurs all year round and most of the ore mined is alluvial. The river garimpos peaked in Madeiro in this region in the 1980's. In the south of Brazil, garimpo activities are seasonal and family based. Outside of the Amazon, there are emerald and quartz garimpos. In the peak of garimpo activities, 500,000 people were directly involved.

It was observed that the Serra Pelada experience had a strong influence on current government thinking on garimpo gold mining activity. More than 200,000 tonnes of gold was extracted and 100,000 people were involved, leaving behind very strong environmental and social impacts. When mining ceased at Serra Pelada, government did not know how many miners had died. Moreover, economic indicators recorded disappointing returns to the state from garimpo mining. Current government policy will therefore only support garimpeiros in areas with no economic alternatives.

In the 1980s, the Government felt that garimpeiro activity was an acceptable way to stimulate economic and social development for economically depressed regions, and as was subsequently shown, it was falsely thought that this was an alternative to poverty and unemployment. However, the Government realized that this was not a sustainable approach for economic development since garimpeiros are nomadic and once the ore deposit is fully mined, they move to another site, leaving behind environmental liabilities and unemployment in the community. Mr. Borges opined that garimpeiros should be allowed to mine gemstones, and construction materials, and posited that small scale-scale mining for non metallic minerals adds more social value to society than gold mining, since jobs, income, income for the state to provide for others, are created. Hence, support will be provided for the less nomadic types of garimpos. Mr. Borges stressed that gold mining should be left to the large companies except in the cases where the gold is not accessible by large mining companies.

Garimpo activities are not sustainable without government support. Government realized that it is difficult to develop a homogenous policy for garimpeiros, since each region has its specific requirements and the policy should allow for a case by case approach. The Amazon region, which supports 70% of garimpo activities, is especially targeted by government policy. A study was conducted in 1991-92 in which 35,000 garimpeiros were interviewed. The study focused on what alternatives are available to garimpeiros.

New government policy is focused on several key points. First of all, garimpeiro activity was legalized from 1989 and their historical rights have been respected. Areas in Brazil have been identified for garimpos and operators have a legal title to their property, which can be used for negotiations, and they must have a Licence to mine. The Government of Brazil, through CETEM provides technical assistance to garimpeiros. The focus of the technical assistance is to increase their productivity, reduce their environmental impact and increase their management capacities.

Garimpeiro activities have been decreasing over the years due to the low price of gold and the high price of fuel, which made their operations not profitable. The number of garimpeiros is now 10% of peak levels of 500,000, and garimpeiros are now willing to negotiate their rights with large companies. In such cases, companies assume responsibilities for the management of the environment. Government is trying to develop alternative activities that will provide the

garimpeiros with economic programs outside the mining sector, and is attempting to decentralize its social and economic programs. The challenge has been the lack of continuity in leadership at the government levels where changes occur every 4 or 5 years in political parties in power, ministers, etc. The solution that was adopted to promote continuity and consistency has been to create a multi-stakeholder, multi-agency project, to ensure long-term commitment to planning small-scale mining activities, land occupation and social and economic development. Geological information must be the starting point.

For more than 10 years, Mr. Borges has been part of a non-governmental multi-disciplinary team involved in outlining a long-term project and making recommendations for project funding. The approach put forward is to develop a geophysical and geological database, to be the basis of defining a zone for large-scale mining operations, through which process opportunities for joint venture partnerships between garimpeiros and companies are expected to emerge. Where there are previous land rights, support will be given for economic and social development. Government will help garimpeiros to organize and to strengthen their social organizations: this is not regarded as the role of the geologist.

If small-scale mining does not make a positive contribution, its impact will be negative, perpetuating the large negative impact that is the legacy of Serra Pelada, where 100,000 persons remain in the area, there are land title issues, conflicts with farmers, unemployed and sick people and a rapidly deteriorating environment. It is critical that the concept of sustainable development should be pursued, and government's view is that the leadership should come from communities to ensure their long-term sustainability, without reliance on the government, whose role should be supportive. Mining companies can also lend support, especially since they face pressure from international public opinion.

### **VISIT TO THE MINISTRY OF ENVIRONMENT**

The meeting was with Marcelo Ribeiro Tunes, Project Manager, and Sustainable Development Secretariat of the Federal Ministry of Environment.

Mr. Tunes was part of the delegation that traveled to Guyana in 1996 to discuss the issue of Brazilian garimpeiros in Guyana and issues relating to the Guyana- Brazil border. Supporting the points raised by Mr. Borges, Mr. Tunes disclosed that small-scale mining is triggered by socio-economic problems. When small-scale miners are dealing with high-valued minerals, this creates social pressures resulting in the formation of temporary towns in remote areas. Social and economic problems associated with garimpeiros are not simply addressed by fiscal measures or enforcement of regulations. Rather, the problem must be analyzed at the root and in a comprehensive manner.

In the 1970's and 1980's, problems peaked, especially in Amazonia. Several policies were tried, unsuccessfully, until the problem resolved itself when the price of gold fell. It is believed that the government is much better placed to deal with the problem in the event of an escalation of gold price. Because garimpo operations are marginal, they were considered to be illegal for many years. Regulations covering their mining and environmental aspects have since been introduced, including instructions on how the regulations should be carried out. However, there is a need to go further. For the last 5 to 6 years the general policy has been for the local (State) authority to be involved through the delegation of Federal authority to issue Environmental Licences required for obtaining a Mining Licence. The States of Minas Gerais, Bahia, and Goias, which all have a

strong mining tradition have already accepted the authority delegated for mining operations. This trend is to be extended to the other States, not only for mining, but also for all sectors.

In 1999, the Ministry of the Environment was divided into five Secretariats, each with a different area of responsibility, in order to erase the dichotomy that environmental protection and development are incompatible. These are: Executive, Environmental Quality in Human Settlements, Biodiversity and Forests, Water Resources, Sustainable Development Policies, and Coordination of the Amazon Region. The Secretariat for the Amazonian Region was created earlier, in 1993, and it administers an area amounting to 60% of the landmass of Brazil. Working teams have been created with representatives from the Ministry of the Environment and other Ministries in order to address issues from all angles. CONAMA, the National Environmental Council consists of 75-80 members from Federal and State agencies, and the private sector. General Standard Rules (minimum standards) are adhered to by all States, with adjustments for the local situation. The Council establishes the Rules and General Standards: the latter are available on their website at [WWW.MMA.GOV.BR](http://WWW.MMA.GOV.BR) (under CONAMA).

Environmental Impact Assessments (EIA's) are required in order to receive an Environmental Licence. Impact prediction and Mitigation Measures to address environmental concerns are the salient features of a scaled down version of the EIA. The State Environmental Agency decides if there is a need for a complete EIA or a scaled-down version. Most of the time EIA's are contracted out by companies, and in the case of small-scale miners, their association manages the process on their behalf. Small-scale miners are not required to submit an annual report, but other operators must submit an annual report to DNPM. Several Brazilian universities have developed graduate level Masters degree programs to simultaneously research environmental issues and provide the expertise to deal with environmental issues. With the development of expertise, there are now exemplary corporations, whereas initially they tried to import inapplicable technology. As a result, today there is an environmental service industry that generates between \$300,000 and \$400,000 US/year.

On the issue of enforcement, penalties were introduced in 1998. These are not only monetary, but also include jail terms. State Environmental authorities also have the right to shut down defaulting operations. DNPM, the Federal Agency, has offices in regions where mining activities are concentrated, and their Inspectors review health and safety, mining and environmental issues.

In some States, there is coordination between the Mining and Environmental Agencies, but there is room for improvement.

No environmental bond is required, but there is active consideration for establishing a trust fund (to be administered through the stock market) for reclamation. Large companies have to make provisions for reclamation in their annual budgets.

The trend is that more emphasis is being placed on air pollution, climate change, etc. Mining companies are generally responsive.

## 2.5 Brasilia and Pocone

### FRIDAY, MARCH 24 – BRASILIA AND POCONE, VIA CUIABA

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#### VISIT TO THE GUYANA EMBASSY IN BRASILIA

9:30 - Mrs. Livan and Ms. Lorenzato met with the Ambassador of Guyana to Brazil, Ms. Maryln Cheryl Miles, to brief her on the visit and discussions.

10:15 – Delegation left for Cuiaba by plane to visit a gold garimpo in Pocone region in Mato Grosso State.

#### VISIT OF THE LAURA GARIMPERA MINE

Mr. Jair de Freitas, Geologist and Head of the Environmental and Mineral Inspection Section of DNPM's regional office in Cuiaba, Mato Grosso, joined the group to travel to the Pocone area to visit the Laura Garimpo operation, the largest and most successful mining cooperative in the area. The visit to the site included viewing the tailings pit from which tailings are extracted and re-processed, the extraction facilities, tailings disposal area, amalgamation shop and the current extraction pit itself, which was not in operation because of high rain fall.

The objectives of the visit were to demonstrate the conduct of mines inspections and the working of the cooperative system that is being advocated and applied in the Brazilian Small-scale Mining Sector.

**Inspection Process:** Mr. Jair de Freitas, explained that his office is responsible for conducting regular and special inspections of mining operations in Mato Grosso State and other parts of the country when needed. The visits of the mining sites are based on a random order or following complaints. There are two officers for each mine site visit, a Mining Engineer who examines specific mining issues and an Environmental Inspector who examines environmental issues (Photo 9).

During a mine site inspection, the first step is to examine the Mining and Environmental Permits for the operation. The inspector verifies the validity of the Permits with respect to date, type of mining and operations, and others parameters. Next, they verify whether the mining and environmental regulations are honored. A report is given to the person in charge of the operation outlining the findings of the inspection; both the good and bad aspects are documented.

If the operation is in compliance with its permits, this is certified in writing, where there is non-compliance in any aspect, the inspectors issue a written warning specifying the nature of the breach, the reason for non-conformity, and the applicable legal requirements. The Inspectors advise the mine operator how to change the situation to achieve compliance. A time frame for corrective action is given with the warning, which is determined by the Inspector based on the nature and severity of the breach. The Inspector makes a follow-up visit to the site to verify that all breaches have been corrected since the first visit. Inspectors work cooperatively with miners and in a significant way, offer technical advice to assist miners.

There are no standards for mining effluents in the regulations applicable to this type of operation. Inspectors make visual judgments about the tailing dams and the effluent, and water quality is

compared visually with that of upstream water. Visual impacts are accorded as high a level of importance as physical impacts. Where there is unacceptable visual impact, the inspectors give verbal advice for corrective action. However, for unacceptable physical impacts, as mentioned above, a written notice is served. If the fault persists uncorrected, the State Environmental Agency is notified. A serious first offense, that is, an area of non-compliance which the operator is not seriously taking steps to redress will result in a fine which can vary in amount based on the gravity of the offence. The maximum fine that can be demanded is \$US80 000. If the offence is repeated the operator faces the real risk of losing his Environmental Permit. The State Agency levies the fines and nullifies the Environmental Permits, and there are allegations of corruption among Inspectors who levy fines.

With no existing standards for mining effluents, it is not surprising that the zero emission principle is strongly recommended by government agencies. Consistent with the principle of zero emission, mining of riverbanks and riverbeds by river-dredges is disallowed. All other types of mining permitted must have effective tailing ponds. The absence or inadequacy of tailings ponds is a serious offense.

Operation of a Mining Cooperative: As mentioned earlier, the Laura Garimpo Gold Mining Cooperative is the most successful in the area. Because of low gold price, high fuel cost and ore reserve depletion, out of 20 mines of this type that were operational some years ago, only eight are still operating. The mine site, which is owned by Sergio de Franca, has the working pit, heavy earth moving equipment; three parallel grinding-gravity concentration circuits, tailings disposal area, five sedimentation ponds and workshops. The three grinding-gravity concentration circuits consist of rod mills, 5-tonne capacity ball mills, classifiers and centrifugal concentrators. Being the rainy season, the pit was flooded and the employees were working and re-processing tailings in order to sustain their employment by recovering gold left from earlier workings. The ore is sulphidic, and the tailings weather to release gold trapped in pyrite. It is therefore likely that acid rock drainage could be a problem.

The pit that was being exploited was worked in sections by five independent groups of miners who have been working cooperatively with the mine-owner for more than 10 years. In this pit, primary quartz veins which cannot be economically worked with heavy equipment are selectively mined and stockpiled manually after the overburden is removed with a shovel/excavator. When the pile becomes large enough, it is loaded by a front-end loader onto 10-ton trucks and taken to the mill, where it is processed in batches. The mill processes primary ore of quartz vein material at a rate of approximately 20 tonnes/hour, while tailings are processed at 40 tonnes/hour.

Tailings from the mill are pumped to the tailings-disposal area. The contained water from the tailings sequentially passes through four ponds and a flocculant, aluminum sulfate ( $Al_2SO_3$ ), is added to promote sedimentation of fine material. Water from the last pit is recycled to the mill and there is no discharge to the environment. The concentrate, consisting of black sand and gold, is transferred to the amalgamation shop where it is amalgamated in an amalgamation drum developed by CETEM, in which water is used to minimize the volatilization of mercury. The amalgam is then burned in a large retort and the gold is recovered. The employees of the shop are aware of the danger of mercury, and they wear gloves when manipulating the amalgam. Water used during amalgamation is discharged into the sedimentation ponds in the facility. The mercury recovered is mixed with fresh mercury in a ratio of 20% used with 80% new mercury,

and this is used for the next amalgamation process. Amalgamation wastes are put in bags and stored in the workshop until an acceptable means of disposing them in the environment is found (Photo 10 to 12).

By agreement, the miners receive 40% of the gold produced from the ore that they extracted. The mine-owner receives the other 60% which pays the cost of mine site, the equipment and facilities and operating costs, including cost of excavation/overburden removal, transport, milling and environmental facilities, and gold recovery process. The contribution of the miners is the extraction of the ore in a cost-effective manner.

An obvious benefit of this cooperation is that less endowed miners gain access to heavy earth moving equipment and facilities for overburden removal, ore transport and processing and tailings handling and disposal in an environmentally acceptable way. This promotes greater sustainability of mining operations, ensures a more regular income and generally higher returns to the miners while eliminating the possibility of environmental damage from several small, itinerant operations.

There are however, negative aspects of health and safety as management of petroleum products is deficient. Miners are allowed to exploit the deep quartz veins with little or no technical guidance, and there is a real risk of an accident. Miners for their part may be tempted to take unacceptable risks since their earnings are directly linked with production. If the relationship between the miners and the mine-owner were to be changed from one of partnership to one of employees/wage-earners and employer, it is likely that the occupational safety aspect for the miners could be improved since the miners may be less inclined to take risks. However, lower earnings may also stifle their productivity. In any event, the mine-owner must bear responsibility for the safety of workers on the mine site regardless of whether they are independent 'contractors/partners,' or if they are employees.

In summary, there are several advantages of a cooperative and symbiotic effort between small miners and mine-owners that possess heavy earth moving equipment and sophisticated processing facilities. Not only are there direct benefits to the mine-owner, miners and the environment, but also larger, mechanized, and more permanent operations can be better administered and regulated by the government. Such operations are better placed to implement facilities and systems for environmental protection, the cost of which is partly offset by higher recoveries in their processing plants. They are also well placed to receive advice from technical government agencies, and to develop better working relationships with such agencies, which can adopt the role of facilitator. Nonetheless, this does not obviate their legal responsibilities for environmental protection and proper occupational health and safety practices, and an appropriate, easy to apply and transparent regulatory regime that is justly and equitably enforced is necessary to ensure that legal requirements are met, even when regulators act as facilitators.

In this way, the interests of the wider public and the cause of environmental protection that underlies the concept of *sustainability* can be well served during gold/mineral operations by small and medium scale operators. The image of the small and medium scale mining industry will be enhanced and will also contribute to the sustainability of the mining sector that increasingly is required to have a '*Social Licence*' to operate and exist. Finally, occupational health and safety issues should not be given less priority than environmental protection by

government regulatory agencies, mine-owners and miners, since human lives are very important, and moreover, poor mine safety practices often translate into poor environmental practices.

The group over-nighted in Cuiaba.

## **2.6 Chapada dos Guimarraez**

### **SATURDAY, MARCH 25 – CHAPADA DOS GUIMARRAEZ**

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#### **END OF THE TRIP**

In the morning, the group visited the national park of Chapada dos Guimaraez, with a scenic backdrop of brick-red sandstone tableland formations deeply eroded by a small river flowing through a canyon. In the park, a waterfall interrupts the river. In the afternoon, the group started the journey back to Georgetown, via Sao Paulo and Miami, and arrived in Georgetown on Sunday March 26.

### **3.0 GENERAL CONCLUSIONS OF THE GROUP: The Brazilian Experience**

The group was able to obtain insight into the development of the small-scale mining sector in Brazil and the evolution of government policy and responses. Over time, riverbed and riverbank mining have been banned and government has encouraged garimpeiros to join together to work in co-operatives, which, as an incentive, are given larger areas to work. Government believes that this pooling of resources will reduce nomadically with attendant benefits for environmental protection, while also making government technical assistance and regulation more feasible. Similarly, operations of individual under-capitalized quarry operators are being discouraged in favour of pooling resources through the formation of cooperatives. Garimpeiros are being encouraged to turn to dimension stone production, since a shift from gold production to dimension stone and semi-precious stones is considered to have greater social value. This is now the preferred direction adumbrated by government policy, except where there are no economic alternatives to small-scale gold mining.

However, cooperatives have generally not worked well, particularly in the gold mining sector, where there is innate mistrust, and where surficial alluvial deposits can be readily worked with little capital or special skills. Marketing of the product is straightforward and well established, and there are no market restrictions, specifications or limitations on the product. The Serra Pelada experience has left a bitter taste in the mouth of the Brazilian government, with its legacy of environmental and social problems, land conflicts and bad international publicity for the Brazilian mining industry.

It is felt in some government quarters that the poor showing of economic indicators for small-scale gold production does not justify the high social and environmental costs and tarnishing of the image of the Brazilian mining sector. Nonetheless, official government production statistics attest to the significance of gold production from small and medium scale garimpeiros, although production has fallen off sharply in recent times in response to falling gold prices and higher production costs.

To underline the shift in government policy, technical support for dimension stone production and marketing is being highlighted, and building on the experience gained from the small scale gold mining sector, government is promoting a multi-stakeholder approach to planning for long term sustainability that goes beyond mining. Technical support includes plans for a regional technical school to be established in northern Brazil to teach technical aspects of dimension stone production. This position contrasts with that of the 1980's when small-scale mining was regarded as a social and economic safety valve, a solution to the socio-economic problems and the existing unemployment crisis. However, for reasons outlined earlier, realistically, not many garimpeiros would be expected to make the shift, nor would the dimension stone industry absorb the large number of garimpeiros. The result is the migration of garimpeiros to neighbouring countries, including Guyana, and a likely resurgence of the problem in Brazil if there is a hike in gold price.

All mining operations have requirements for environmental protection/environmental permitting although reporting requirements and the scope and detail of Environmental Impact Assessments vary. For small-scale gold mining, the requirement to have settling ponds is strictly enforced, and zero discharge is encouraged for gold and also for quarry operations. There are also requirements for the use of retorts and that amalgamation tailings should not be discharged into the environment. CETEM is working on two pilot scale operations to find solutions to the problem of disposal of amalgam tailings, using the batch Electro-leaching (electro-oxidation) process that they developed and are now perfecting. CETEM also developed an amalgamation drum, mercury retort, and information on the hazards of mercury for miners.

Two multi-disciplinary studies on the socio-environmental impact of small-scale gold mining were carried out by CETEM in the 1990's, in Pocone in northern Mato Grosso State and Alta Floresta in southern Mato Grosso State. The studies showed that there were impacts from siltation of rivers, mercury contamination and bioaccumulation in the food chain, and mercury contamination of soils near the gold buying shops in Alta Floresta. In addition to these initial studies, CETEM and Brazilian Universities are studying, assessing and seeking solutions to environmental problems, and developing appropriate technologies and human resource skills to address Environmental Impact Assessment, Monitoring and Mitigation.

State and Provincial Environmental and Mining Agencies/Ministries are working together, but there is room for improvement. Their approach is work collaboratively with miners and to offer technical advice in cases of non-compliance, to help defaulting operators to achieve compliance. This is supported by the enforcement of regulations through the State Environmental Agency.

The Federal Ministry of Environment has responsibility for the development of Environmental Standards and Guidelines with the National Environmental Council, a multi-stakeholder body, playing a leading role. General Standard Rules, which are minimum standards, are adhered to by all states. The standards and guidelines are available to the public on the Internet. There are no discharge limits for small-scale gold mining operators, and zero discharge is encouraged, through the operation of settling ponds, and recycling of clarified water.

Enforcement of Environmental and Occupational Health and Safety Regulations continues to be a problem. Although the Ministry of Environment can levy penalties in the form of fines and jail sentences, these are not always effective.

Despite the social and environmental problems resulting from mining, Brazil is forging ahead with promotion of its mining industry and mineral production. Focus is being placed on the Amazon region, which is well endowed with mineral deposits and constitutes 60% of the Brazilian landmass. A large campaign of airborne geophysical surveys and follow-up ground geological and geo-chemical mapping is being undertaken from 2000 – 2002, to promote mining in this region that is internationally acclaimed to be an important part of “the lungs of the earth”. Government is also actively considering opening to mining on a case-by-case basis, lands of indigenous people, which make up a significant 12% of Brazilian territory. Large-scale mining is being promoted and small concession holders are encouraged to join together with large investors. Available geological information will be the key and the basis for zoning and delineation of target areas for proposed exploration.

### 3.1 Lessons for Guyana

Guyana can learn from the Brazilian experience, especially the new policy direction of applying a more holistic approach to mining that will work towards attaining sustainability in mining operations, and where applicable, sustainability in communities at the end of mining operations. However, significant differences in the Brazilian and Guyanese mining experiences must be acknowledged, and solutions to challenges facing the Guyanese industry have to be tailored to suit its special circumstances.

There are similarities in both approaches that ban mining of riverbanks, and favour mechanization, with the application of 'dry mining' techniques using heavy earth moving equipment. Sharing of processing plants is envisaged, as is the provision of technical assistance to help miners achieve higher gold recoveries while employing more environmentally friendly mining, processing and tailings and waste disposal techniques.

Encouragement of zero discharge to the environment and compulsory use of tailings settlement ponds, with recycling of water, even in the absence of discharge limits, is a useful strategy that could be given consideration in Guyana, at least at the medium scale. It should be noted that a flocculant is added to aid the settling of fines, and that suspended solids are a major source of transport of mercury.

For the medium to long term, directing medium scale operators into the production of industrial minerals, including dimension stone, is a strategy worthy of consideration. However, Guyana does not have the Brazilian advantages in the traditional production and use of dimension stone and a large domestic market in which to sell dimension stone products. For medium scale operators, government technical assistance and assistance with marketing will be important.

Disposal of amalgamation tailings is problematic, and CETEM is working at the pilot scale to perfect a batch process that will recover mercury and gold from amalgamation tailings.

These factors were reiterated:

It is difficult to find a cheap efficient and easy to apply replacement to mercury amalgamation for the recovery of gold from black sands concentrates; retorts are useful for protecting miners' health and reducing the amount of metallic mercury discharged into the air through open burning of amalgam. In Alta Floresta, it was found that 70% of mercury losses during the amalgamation process occur as vaporized mercury from the burning of amalgam.

- Universities provide useful information and skills to be applied to Environmental Impact Assessment and Mitigation, through research programs at the Masters degree level. This contributes to the development of appropriate technologies for environmental management. Sectoral research agencies and institutions can also contribute greatly to research and development efforts, and through their role of offering technical assistance advice, they can promote the adoption of new and better practices for mineral recoveries and environmental management, and refine existing technologies to better suit local physical and operational conditions.
- The multi-disciplinary and multi-stakeholder approach is a useful one to be applied within agencies and across different interest groups, to examine problems and challenges,

devise strategies and find solutions to issues of environmental protection and economic, social and environmental sustainability during and after mining. This approach, though painstaking, is useful in that confidence building and consensus form its bases, and it takes a holistic, comprehensive view of the effects and benefits of mining.

- In spite of good working relations and collaboration between regulatory agencies and mine operators, enforceable regulations are necessary to provide a practical legal mechanism to ensure that breaches are corrected, and persistent breaches are penalized. Where enforcement is lax, environmental damage is perpetrated since mine and quarry operators have no incentive to improve their operational performance.
- GGMC and the Mining Sector can benefit from ongoing links and collaboration and information exchange with Brazilian Sectoral agencies – CETEM, Geological Survey of Brazil, and Ministry of the Environment. Such links/collaboration must be tailored to suit the financial restrictions operating in these agencies.
- It is apposite to note that in spite of negative social and environmental impacts resulting from small scale gold mining and calls from international conservation groups for protection of the rainforest, the Brazilian government is marketing the Amazon region, which accounts for 60% of its territory, for mineral development. Mineral Development is to be carried out in the context of its 'sustainable development policy', which holds the view that development and environmental protection are compatible. The policy makes ample provision for conservation projects such as the project for the sustainable use of Amazon Biodiversity, development of eco-tourism and support for agro-extraction with the participation of local communities - Indians, riverside communities and extractors of rainforest products. There is also a pilot program to conserve Brazilian Rainforest. Projects for the recovery of degraded areas are to be implemented.
- It is of interest to note that the sustainability of the small-scale gold mining sector in Brazil is considered in part to be tied to its contribution to the national economy. To this end, perceived under-performance, pitted against negative environmental and social impact, are factors that have influenced the development of current Brazilian government policy towards the promotion of dimension stone over small-scale gold mining. This has to be taken in the context of the dominance of large-scale mining of gold and other minerals, in Brazil.
- Falling gold prices, resulting in reduced mining activity, contributed to a partial default solution of the Brazilian garimpeiro problem of environmental impact from itinerant operations, and led to migration of garimpeiros to neighbouring countries, including Guyana. A hike in gold prices could cause a resuscitation of the problem in Brazil, and similarly, there could be a sharp increase in operations in Guyana. The Brazil Environmental Agency feels that it is in a better position to deal with such an eventuality. In formulating our plans, programs and strategies, GGMC should take this probable occurrence into consideration.
- Finally, as medium scale operators start to work pyritic/sulphidic ores, acid rock drainage can result as sulphides become exposed and oxidized at the surface.

## **APPENDIX A**

### **CETEM Overhead Presentation and Papers**

## **APPENDIX B**

### **CPRM Organizational Chart and Overhead Presentation**

## **APPENDIX C**

### **Photographs**

## **APPENDIX D**

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## **APPENDIX D**

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