



# **Global Mercury Project**

**Project EG/GLO/01/G34: Removal of Barriers to Introduction of Cleaner Artisanal Gold Mining and Extraction Technologies**



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## **Information on the chosen sites in Brazil for the Environmental and Health Assessment**

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**November 12, 2003, Luang Prabang, Laos  
April 13, 2005, Brasília, Brasil**

## INTRODUCTION

This document was prepared in accordance to the guidelines set by the PCU for the Luang Prabang's Global Task Force Meeting , from 17 to 19 December 2003 , and the beginning of the Awareness Campaign in Brazil, April 13<sup>th</sup>, Brasília, Brazil, as referred to UNIDO Contract 03/014.

It consists of a description of the Brazilian selected hotspots gold producing sites , i.e., Creporizinho and São Chico , at Itaituba County , State of Pará , Brasil , their extraction and processing characteristics and the environmental and health impacts, so far detected .

Since at this same GTFM a separate section is programmed dealing with the actual findings of the latter, i.e. the environmental and health impacts field campaign in Brazil , conducted August 2003, details of such an account will be left to Dr. Saulo Rodrigues Filho , team leader of the aforementioned UNIDO contract and special invitee for this meeting .

Furthermore, the basis of this document were the reports on the Sociological Aspects , by Armin Mathis , Extracting and Processing Aspects , by Alberto Rogerio da Silva , Field Report on the Tapajos Visits by Christian Beinhoff , Mercury in the Tapajos Basin book, edited by Roberto C. Villas Bôas, Christian Beinhoff and Alberto Rogerio da Silva, resulting from the from the first Country Task Force Meeting , in Belém, 2001, and the Preliminary Field Campaign Aspects on Environment and Health , coordinated by Saulo Rodrigues Pereira Filho , available for the focused areas , plus this author's and others papers indicated throughout the document .

## DESCRIPTION OF THE SELECTED SITES

No further reasoning on the need of conducting this overall EG/GLO/01/G34 project will be given , since it was already subjected to earlier discussions on goals , objectives , relevance , social and environmental impacts, and its relationships to international transboundary waters ( SLIDE ZERO).

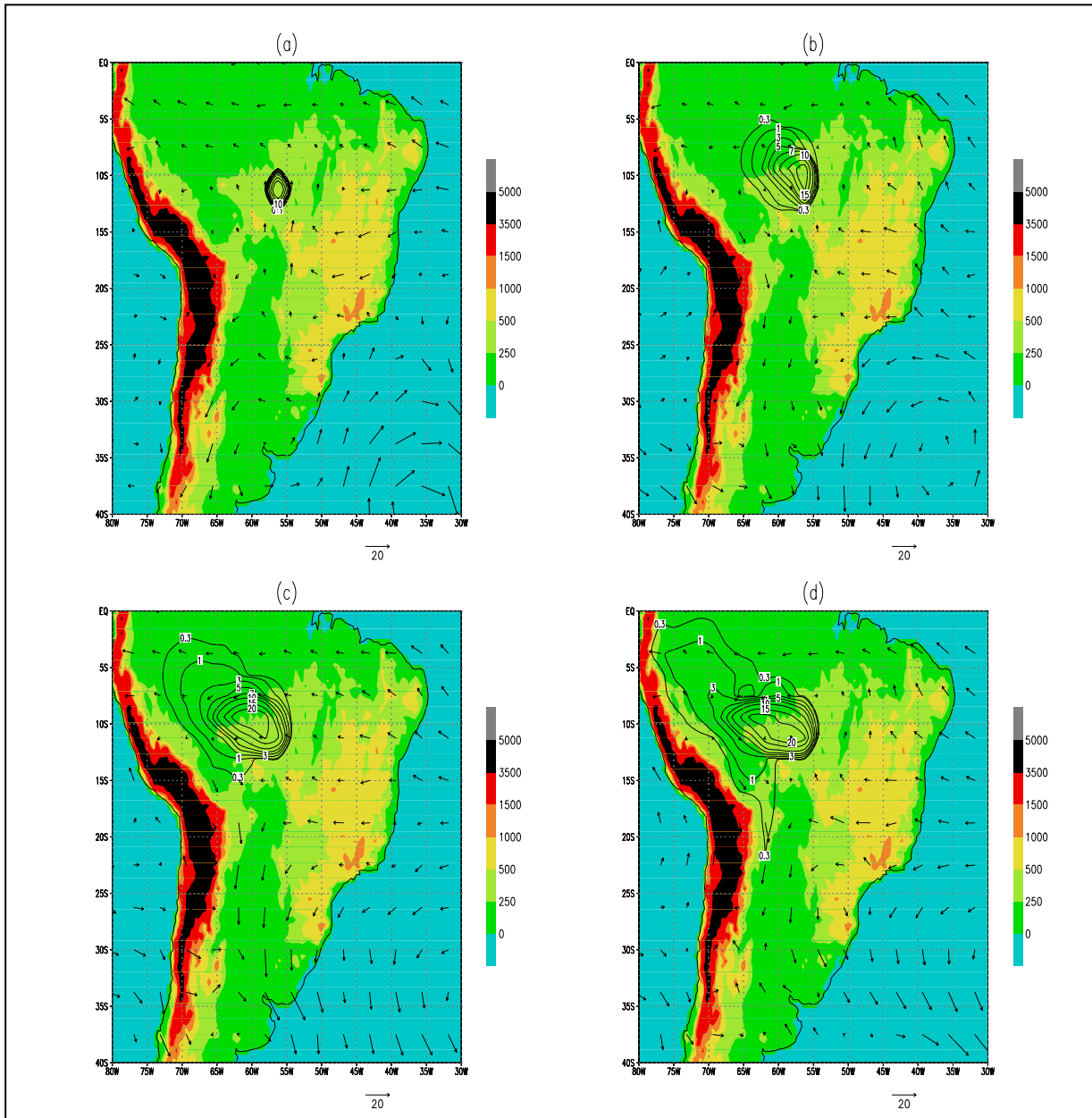
As well , needless to mention at this GTFM the enormous importance of the Amazon River Basin, not only to Brazil and America, but to the World .

In the Amazon Region, *garimpo* , i.e., the Brazilian term for informal mining, (SLIDE TWO) occupies an area of 236,000 km<sup>2</sup> , corresponding to 4.34 % the total area . In the Sate of Pará , alone, the area reaches 150,000 km<sup>2</sup> being Tapajós the largest **garimpo** area in the world - 100,000 km<sup>2</sup> - and the most important gold producer, via **garimpo**, in Brazil (SLIDE THREE).

The main characteristics of Tapajós are:

1. it is the principal Brazilian gold **garimpo** location with an official area of 28,000 km<sup>2</sup>, for such an activity ; however its real area is of the order of 100,000 km<sup>2</sup> ! Just for the sake of comparisons and an orders of magnitude : Portugal , in Europe, has 92,000 km<sup>2</sup> ; Switzerland and Nederland ,together, 75,000 km<sup>2</sup> .
2. **garimpo** in the area started back in 1958, the historical production of about 10 to 12 ton a year, constituting the world's biggest gold producing area, having nearly 500 airfields.
3. gold is extracted in both secondary and ,nowadays, primary, deposits and more than 2,200 mining sites have been detected.
4. such an area has circa 500 occurrences detected for primary gold, including near 200 of quartz veins, of which circa 100 are in activity.
5. also, worth mentioning , Tapajós was the first area to organize a formal association of the owners of the **garimpo** ,called "Associação dos Mineradores de Ouro do Tapajós" , better known by its acronym AMOT .

The selected areas of Creporzinho (06 30'17''S and 56 35'06''W) and São Chico ( 06 25'31''S and 56 02'99''W ), are located in the Rio Tapajós river basin , situated in the SW of the State of Para, Brazil, distant 1,300 km straight line from Santa Maria de Belém do Grão Pará , better known as Belém , State Capital ( SLIDE ONE) .



SLIDE ONE : Transboundary characteristics of gold garimpo extractions in Brazil ( see reference).

To Creporizinho there exists regular flights from Itaituba , the capital town of the municipality of the same name, via twin engine airplanes with a passenger capacity of 09 people , which flies whenever there is sufficient customers at a round ticket priced USD 173 ; São Chico may be reached by both road and aerial access, although road access from Itaituba advisable only in summer time (no rains) and taking around 10 hours to be reached ; aerial access to São Chico only via freighted plane, at a price of

USD 733 for each leg ; a road access Creporizinho – São Chico also exists , 98 km , again, only in summer time, via motorbike ( USD 50) or pick-up truck (USD 100 for 5 hours trip ).

These areas have been selected after a visit to Itaituba to discuss the issue with AMOT and constituted local authorities for mining and environment ( see Beinhoff's Report ) plus a stakeholder meeting held in Belém in 2001 ( see Mercury in Tapajos River Basin book ), previously to project implementation , where the following items of discussion were deeply considered :

- Commitment of the miners with the objectives and goals of the project ;
- Their association with local **garimpo** leaderships;
- Production potential and economic stability of the mining activity;
- Representative sites in relation to regional standards of technologies and practices;
- Accessibility of the chosen sites;
- Spreading potential in relation to the achievements and results of the project .

### **CREPORIZINHO (06° 30'17"S and 56° 35'06"W)**

Creporizinho might be considered to be a typical gold mining village of the region backed by some degree of civil infrastructure ; three churches , one catholic and two protestants , a large variety of grocery stores ,and specialized stores for clothes and shoes , a police station with one responsible officer, one corporal and one soldier . Also, some 238 houses for an estimated population of 1000 inhabitants, besides a grocery , a pharmacy and a lodge. Electricity is generated from diesel engines. The existing 200 children go to the local elementary school, from 1<sup>st</sup> to 6<sup>th</sup> grade, where 4 teachers, a caretaker and a cook perform their educational duties. There are four gold buyers at the village , no dust or gaseous collecting hoods at these buyers are available .

Five oil retailers , selling circa 100.000 liters of fuel oil monthly, provide the necessary fuel for the gold diggers , around 90% and electric power generation , 10% .

Health care is provided by a public health post, which carries out malaria tests and provides medicine in case of malaria fever ; also a health agent at the village , who is paid by the local authority. People can apply for an appointment with a MD, who flies in, if enough patients ask for at a check-up cost of R\$35 , approximately USD 12.5 at November 2003 exchange rate. The area is malaria infested and therefore child mortality is high. Other infectious diseases with high prevalence are Dengue and venereal diseases . Occupational exposure to mercury is recognized as a health risk.

Such mine town , locally called "*currutela*" was founded in 1962 , and accessible only by boat first , then air , in 1974 and latter on , in 1986 , with the construction of the *Transgarimpeira* Road , by land . Its top gold production was between 1983 and 1990 , where productions of the order of 350 to 400 kg of gold per month were recorded . At that time 10.000 inhabitants were living there and the town had 3000 registered voters !

Today, Creporizinho is used as a logistical base to work fronts located within a 10 km radius ; according to Mathis around 60 pairs of machines and 15 shafts are active in the region , thus indicating a population circa 350 people directly working in these sites , 300 gold diggers and 50 cooks , with a **guessed monthly production of 50 kg of gold, circa .**

A comprehensive description of house profile , population profile, social organization, **garimpo** sites, workers profile, with tabulated data of Creporizinho and its inhabitants is found at the aforementioned Mathis' Sociological Report .

The garimpo area can be reached from Creporizinho ,with a four-wheel drive car, within one hour.

In this region, Mr. Tolentino's site ( S 06 47'51.4'' and W 56 36'13.8'') is worth mentioning for the remaining of EG/GLO/01/034 project and Rodrigues Filho's presentation .

The gold bearing quartz veins (*filão*) are in close vicinity to the processing and extraction sites.

### **SÃO CHICO (also known as Fluminense) (06° 25'31"S and 56° 02'99"W)**

Discovered in 1963, São Chico is passing through the initial stages of a transition from *currutela* , local name for a settlement erected out of a **garimpo**, to a village ; from 1986 onwards , with the opening up of the **Transgarimpeira** road , the accessibility of the place, previously reached only by small airplanes , lowered significantly the costs of production and maintained the feasibility of exploitation even during the crises of the 90's .

The site reached its top production during 1999 to 2201 when declared productions of circa 2 tons of gold were reported and the population peaked about 5000 people .

Two years after that rush , São Chico shows little activity ,with an estimated **gold production of 1 kg per month , slightly higher in summer months .**

São Chico is just 2 km away from a local airfield and at 5 km distance from a rough road access, which during the dry season , so called summer time , (June-September) is used for transportation of materials, equipment and supply from Itaituba, the already

mentioned main town of region with 150,000 inhabitants , lying away some 350 km distance and needing some 30 hours to overcome this distance !

In contrast to Creporizinho, this *currutela* consists only of 63 houses along the old landing track and 4 out of these destined to public use, 3 are for commercial uses , eight abandoned and a total of 49 inhabited for a registered population of 134 individuals . The only public service is a health post for malaria and the police station has been abandoned for 3 years ; there are 3 diesel retailing stations , four gold buyers and the village elementary school installed in January 2003 , interrupted its activities in June 2003 ! There is just one public telephone . As stated by Mathis “There are no forms of civil organization in the village . The only form of organization is through the protestant church “Assembléia de Deus” gathering 30 people ”

As for Creporizinho , Mathis’ Sociological Report on São Chico is worth reading , since it is, as well, very comprehensive, listing and locating all active **garimpo** sites, except one, number of working people, working contracts, area covered , machinery employed, gold purity, etc...

At this location Montanha site ( S 06 25’04.4’’ and W 5558’07.5’’) is worth mentioning for the objectives of EG/GLO/01/034 Project and Rodrigues Filho’s presentation .

## **HISTORY OF MINING ACTIVITIES**

In order to grasp the gold potential of the Tapajos area the following table is self explanatory . Tapajós historical official gold production is of 180.6 metric tons, reaching a value of US\$1,915 million . Nonetheless, the estimated real production is circa 650 metric ton (US\$ 6,877 million). Between 1993 and 2002, it represented 36 per cent of the total State of Para gold production, three times more than the Cumaru-Redenção-Tucumã Region and ten times more than any other gold production area. It is very important that the gold performance of Pará is very much influenced by Igarapé Bahia gold mine , located in the Carajás mineral province , and belonging to the Companhia Vale do Rio Doce - CVRD- producing around 10 tons per year .

**Table 1 - Tapajós historical official gold production**

Period	Volume - ton	Value -US\$ million
1958-60	2,4	2,4
1961-70	6,2	19,2
1971-80	13,1	110,3
1981-90	86,4	1.085,6
1991-00	67,5	692,30
2001-02	5,0	50,00
<b>Total</b>	<b>180,6</b>	<b>1.959,80</b>

Sources: DNPM, Seicom and LME

However, some characteristic moments of the **garimpo** activity in the State of Pará are of interest to this presentation and a brief discussion is herein presented .

*Before 1978, garimpo* activities were regulated by the Mining Code (Law 227/67).Such a Code defined **garimpo**’s worker , called *garimpeiro* , as a professional who is entitled to exploit surface deposits, typically alluvial and superficial laterites (secondary enriched gold bearing ore associated with iron oxides and hydroxides extremely widespread throughout Brazil), manually , although utilizing the normal manually excavating tools, as hoes, shovels, picks etc. If labour is conducted in deeper deposits , a diesel pump might be allowed. As such , the operation produces few tailings, gold is recovered in small concentration sluice boxes , lined with carpet and having crossed rifles to hold heavier gold particles ; the carpet is washed out , the particles amalgamated with mercury and the amalgam is burnt open air. Normally these manual operations do not constitute a serious menace to river drainage systems nor the environment , except for the eventual small spillage of metallic mercury and fumes from the burning of the amalgam .

*After 1978*, with the gold boom promoted by the fantastic new prices reached at the international metal markets ,easily accessible flat alluvial, and laterites in general, were so demanded that, as normal, they just ran out of existence and new deposits were thus sought , as... the river beds ! The Mining Code was not obeyed anymore and machines were largely utilized ,as dredges or rafts, for that matter. These operations were common all along the Rio das Tropas River, in 1977,a tributary of Tapajós River. One

year after, at the Rio Marupá River, also a tributary of the Tapajós River, extracting was at tremendous production rates and very successful .

Dredges or rafts are responsible for gold extraction on the sediments of the main drainage systems .

As the river beds were depleted and other sources were found as *sequeiros* (elluvial and colluvial ores), through *chupadeiras* or *par de máquina* , a local denomination for the two suction pumps, the first one, to remove the overburden and the other one, to make the suction of the gravel or mineralized level.

Interesting to note an apparent contradiction , and also the explanation for the preference of the usage of **garimpo** instead of small scale mining or artisanal: in fact , garimpo operation does remove large masses of ore, using very potent machinery; however, the final concentration continued to be performed at the traditional *cobra-fumando* ( rocker or sluice ,sometimes shaped as a long-tom, carpet lined for recover gold concentrates ). As a consequence of the enormous tailings produced by the employment of such ( dredges and rafts ) machines , river drainage and nearby landscape suffers from its discharge and presence .

*In 1988* , a new Constitution was promulgated allowing the Federal Government establishing designed areas for **garimpo** under preset rules ,aiming the association into cooperatives and giving the existing **garimpo** priority for prospecting and extracting deposits which could be exploited by such a way. By 1989 Law 7805 was passed instituting the **Permissão Garimpeira** (a Permit to work ), with in built incongruous articles which do not considered the several different cases that might be at play , as for instance the constitution of small mining companies ( not only cooperatives ) , the size of the areas the **garimpos** are allowed to exist , etc...

*Nowadays*, regardless of the legal imbroglio , some **garimpo** reached the primary quartz veins, whose entire exploration and exploitation technologies is totally unknown to them.

It is claimed that there is a declared tendency for a harmonic coexistence between **garimpo** owners and mining companies, through the establishment of joint ventures as one of the most interesting alternative in advancing in the evolution of **garimpo** activity to a real mining enterprise ; the companies are conscious that the works developed by **garimpo** might be of help to them ,in order to minimize geological prospecting initial capital risks , due to the famous one million troy ounces “rule of thumb” of gold contained in ore bodies, which then starts to be of interest for the mining companies .

Between 1990 and 1999, the government of Pará and AMOT promoted joint ventures involving international mining companies and **garimpo** , reaching some 35 negotiations (joint ventures) involving 19 mining companies. All negotiations had the AMOT participation (SLIDE FIVE ).

**Table 2 – Tapajós Region JV**

Company	Country
Barrick Gold	<i>Canada</i>
Rio Tinto	<i>England</i>
TVX Gold	<i>Canada</i>
WMC	<i>Australia</i>
Pegasus	<i>USA</i>
Placer Dome	<i>Canada</i>
Homestake	<i>USA</i>
Minero Peru	<i>Canada</i>
Newmont	<i>USA</i>
Austral Inc.	<i>USA</i>
Rio Algom	<i>USA</i>
Jordex	<i>Canada</i>
Enterpa	<i>Brazil</i>
William Resources	<i>Canada</i>
Golden Star	<i>Canada</i>
Phelps Dodge	<i>Canada</i>
Anaconda	<i>Canada</i>
CVRD	<i>Brazil</i>
New Bullet	<i>Canada</i>

Source: Seicom

However, after the Brie-X incident and the collapse of the Vancouver Mining Stock Exchange none of these proceeded further . On the subject worth mentioning this author's paper presented to OECD in Paris on "FDI in Brazilian Garimpos " , available at <http://www.oecd.org>

## **MINING EXTRACTION AND PROCESSING CHARACTERISTICS**

Tapajos area is subjected to **garimpo** since 1958 , and due to the overall historical and legal background earlier described, an evolution from earlier manual exploitation methods to mechanized machinery methods , is herein presented.

Nowadays , as reported on Mathis' Sociological Report and da Silva's Extraction and Processing Report, rudimentary cyanide processing is in (mal)practice in the region - the dangers of it , not only to living organisms , men included, to tropical compartments has to be ever emphasized - ;however , since it is outside the scope of present document it will be not touched here , leaving as well , any comments on this to the section on the Brazilian Field Campaign .

## **MANUAL METHOD**

The manual method is an ancient and most traditional way to recovered gold since this metal has been of interest to human beings. It consists in using of simple and rudimentary equipment. Normally the area to be exploited is alluvial flat or outcrops and laterites, the art of recovery following some simple rules: after removing the mineralized bearing material, gold is recovered in a rocker or sluice box (*cobra-fumando*, as called in **garimpos**). At the rocker or sluice , carpet lined – carpets are in use since the earlier days of the Californian Gold Rush, whenever available, and it is worth mentioning Von Bernewitz' words in his 1926 "Handbook for Prospectors and Operators of Small Mines", McGraw-Hill, : "Improved savings of fine gold may be made by laying on the bottom of a sluice such materials as blanket, burlap, canvas, carpet, coco matting, corduroy, cowhide with the hair on , moss, and sponge rubber, held in place by cleats or wire in some form " " - mercury is added to amalgam gold , water being added throughout the operation. For separation of the amalgam a piece of cloth is used , twisted enough, thus liberating the amalgam from the solid and remaining liquid effluents; once the amalgam is thus obtained it is burned in open air .

## MECHANIZED MACHINERY METHODS

The methods that follows , all mechanized in the sense that utilizes heavy machinery and energy , only varies in the way they dismantle the ore body , being the production of the ore concentrate and amalgamation about the same .

### 1. Dredge or Raft Method

Dredge and raft is considered an “advance ” in **garimpo** gold production in the Tapajós Region. These ancient methods, although using modern and more powerful machinery - the difference between dredge and raft being the underwater operation of the later, where a diver manually directs the suction of the material to be brought to the concentration equipment - , utilize hydraulic controlled suction pumps to recover the ore bearing masses, were introduced for recover mineralized level or gravel at the active alluvial sediments in the main drainage of the Rio Tapajós River Basin.

Typically a dredge or raft is mounted on two wood boats or two iron tubes, having circa six meters in length each, hanging the diesel motors (from 40 to 65 HP) on boards. It is covered with nylon protection and move along the river drainage engineered by 15 HP Yamaha boat motors.

The larger horsepowerd engines move a centrifugal pump mounted on to two hoses with diameter from 4 to 6 inches. In one of the hoses, whose extremity is inside water, a scrapper , called locally e *abacaxi* , denomination to define metallic cylinder utilized to provide suction of gravel or mineralized level. Such *abacaxi* makes suction of the gravel or mineralized level from drainage’s bed, underwater. The suctioned material is brought at the surface thrown at a sorting screen which screens the gravel and dumped to a box containing carpet and transversals barriers to concentrate the gold bearing particles.

To the final concentrate thus obtained ,after washing out the carpet, mercury added at the *cobra fumando* sluice boxes , revolved in a drum , where mercury is further added for better amalgam results , filtered in the same way that was described for the manual operation and the amalgam burnt , also the same way .

### 2. “Chupadeira” or “Par de Máquina” Method

The *chupadeira* or *par de máquina* , the local names for hydraulic monitoring dismantling operation obeys the following work sequence: first is clearing of the *barranco* , i.e., getting out of the vegetable covering ; second is the dismount and dismantling of the *barranco*, accomplished by two jet nozzles , high pressure water pumps; one cutting and washing the *barranco* (having a hose of circa 2 to 3 inches of diameter ); and the other to adjust the dilution of the thus formed pulp and sending such a pulp to the upper box, where a sorting screen screens the pumped material , and

a bottom box, carpet covered, fixed by slat transversals, collects gold. After, the same aforementioned procedures do follow until gold is produced !

### 3. Hammer Mill Method

The hammer mill method started up in Tapajós Region , following the discovery of primary gold in quartz vein. The operation sequence has the following steps: first , the dismount of the material in situ ; second the carrying the ore to the hammer mill . The mill then grinds the ore and after grinding the pulp is then transferred to the sluice box and the remaining steps are those aforementioned for the previous methods

In all methods so far mentioned the produced tailing are throw into river drainage or pits close to gold extraction operation , thus producing an enormous volume of discarded material which unemployed or others nearby try to get the remaining gold ; locally it is called *reque* or *reco* (little ore material volume with lower gold content that unemployed *garimpeiro* , local name for those who labour at **garimpo**, works out).

## ENVIRONMENTAL AND HEALTH IMPACTS

Since this section will be presented in detail by Rodrigues Filho , this author will concentrate , briefly , on the more general aspects .

**Garimpo** , per se, alter the environment and occupational health of its affected surroundings and people due to TWO major problems : release of mercury into biota and atmosphere AND promoting silting out of the river basins and streams , not to mention the “moon landscape” aspects of the extracting , and surroundings , sites and some deforestation – in order to set up the **currutela** and extracting sites.

*As for mercury*, which is , by the way emitted from several natural and anthropogenic sources, its main concerns are that mercury itself and its compounds behave exceptionally in the environment and inside living organisms due to their particular physico-chemical reactivity , volatility and enormous capability for ... methylation . The well known Minamata and Irak cases , the former linked to direct mercury chemicals release into Minamata Bay and the latter due to mercury containing pesticides for agricultural purposes being the most extreme cases, thus far known .

Also, reemissions to the atmosphere, either from water bodies , in Sweden and the border of the USA and Canada , or terrestrial , as the Carson River Superfund , in Nevada , USA – in the latter circa 150 to 400 kg/year - , are reported !

At Mercury Mines, those who produced mercury, the concentration of this chemical element in the biota at different organs of wild deer at the surroundings of the Idrija Mine, in Slovenia, Gnamus et al. in 1998 reported concentrations 100 times higher than that of the controlling samples ; or at the Monte Amiata Mine , in Italy , mushrooms

having as high as 15% of methylmercury than that of the control were reported by Bargagli and Baldi, in 1984.

As for some systematic field campaign that CETEM and collaborators carried out from 1989 to 1993 in the Pantanal Region and some southern amazon areas of Brazil , it was found that in almost all **garimpo** tailings mercury is presented as metallic mercury, water soluble mercury being generally less than 0.1% of the total Hg content, its distribution in the tailings a function of the location of the garimpos rather than any geological process , higher concentrations at the tailing ponds where amalgamation is practiced . Mercury present in gold extraction areas might represent an important source of contamination for centuries after the closing of the extraction, as pointed out by Lacerda & Salomons, in 1999, and as represented by the real Carson River Superfund site .

Besides , in tropical biota , the reasoning led by Duursma, in 1995, : “Are Tropical Estuaries Environmental Sinks or Sources” , has to be , always, present .

As for the particulate matter , in the amazon region, physical and physico-chemical impacts on the environment and local health deriving from extraction activities were already discussed by Villas Bôas back in 1995, as dusts coming from mining activities for bauxite, iron ore, manganese and sediments and tailings from gold and tin **garimpo** , as erosion and increase of suspended load, changes in color, turbidity and water properties ; silting out , alterations in river courses or even disappearance of such rivers ; the ever present soaps and oils used in the extraction methods . All these cause damaging of life organisms , damaging of fishery, increasing water treatment costs, endemic diseases, etc...

Worth mentioning that the **currutelas** were formed without any previous planning, immediately impacting the region, normally an envious region before, causing a tremendous population increase and a chaotic societal life, having no sanitation or public health available, and, as an expected pattern , no environmental or major health concerns regarding the effects of the activity they are thus dedicated .

As time goes by , evidently , as usual, the **currutelas** transform into villages , these into towns and some as real cities , and social transformations do occur , as it is the normal pattern .

The effects of **garimpo** can be observed some 300-500 km down stream, in the RioTapajós river basin, up to the amazon city of Santarém .

At da Silva’s Report a complete , the most complete, by the way, data bank ever on mercury affecting the Brazilian amazon region shows 29 files, of 6.219 mercury samples, including 32 organic mercury samples ,all collect from 1989 to 1998, regarding the Rio Tapajós Basin, at the locations of Aveiro, Barreiras, Brasília Legal, Itaituba, Jacareacanga, Saicinza, Santana do Ituqi and Sao Luiz do Tapajós. Very worth reading through it !

As for the Creporizinho and São Chico I let the podium to Rodrigues Filho and his presentation .

## **SOME FURTHER THOUGHTS**

For the planned campaigns that are envisaged by EG/GLO/01/034 project worth mentioning some ancient techniques , although nowadays sometimes still utilized with success and sometimes not used at all and blamed for not being workable .

These are : retorts and copper plates !

*Retorts* are known and used to burn the amalgam and recover mercury since Agricola's time , or even before ; notwithstanding, it is quite seldom utilized by **garimpeiros** or small scale plant operators , throughout the world, on the basis that they are cumbersome to operate, decreases gold recovery and produces a "burned " or "dark " gold . Thus, amalgams continue to be burned open air damaging the health of the burner himself and releasing mercury and oxidized mercury to the surrounding air , promoting all kinds of the effects aforementioned presented . Is this a matter of legislation ? enforcement of law ? education of the **garimpeiros**? lack of proper equipment? Or what ?

In fact is a mixing of all these , but mostly , due to the "farwestern" living conditions normally found in these areas , but not always, just lack of real understanding of the mercury effects on their own health and consequences, since retorts are cheap, or may be so, readily manufactured , or may be so , easily operated , or may be so, and really avoid intoxication by the one who is burning the amalgam !Also, important to note , many of those that claim retorts do not work , just submerge the end of the mercury condenser pipe in the water bucket, when using it !

The solution ? From my viewpoint EDUCATIONAL campaign showing the damaging effects of mercury to the health of their children and family ; worth mentioning the projection , in extremis, of the Minamata movies available ...

*Copper Plates* : back , again , to the words of von Bernewitz , found at the aforementioned Handbook " Pure copper 7/64 inch thick, is rolled into plates or sheets for the amalgamation of gold ; 2 to 4 square feet is used per ton of ore per day. New or used plates are procurable, but care should be taken in selecting old ones because they might be uneven or thin and have small holes . Copper plates are scoured with sand, washed with a strong solution of soda ash, and then rubbed with a rag in a 1 per cent solution of sodium cyanide. The plates are then washed with water, and a mixture of fine sand, mercury, and salt ammoniac is applied with a stiff brush until the plate acquires a thin film of mercury. Half an ounce or more of mercury per square foot of plate is the squeezed through fine-woven cloth on the plate and rubbed in with a piece of rubber or a cloth soaked in a ½ per cent solution of cyanide, and the plate is again

washed with water. A coating of silver amalgam ( made by dissolving silver foil in mercury or adding a 10 per cent solution of silver nitrate to the mercury) is advantageous, according to Denver Equipment Company .

## **REFERENCES**

Those mentioned throughout the text .

Best amalgamation will be obtained when :

1. The ore is finely enough ground to liberate the gold.
2. The pulp is dilute enough(20 per cent solids or less) to allow the metallic particles to settle to the mercury
3. The slope (of plates) is enough to prevent sand accumulation( $3/4$  to  $1\frac{1}{2}$  inches for soft ore and  $1\frac{1}{2}$  .to  $2\frac{1}{2}$  inches for heavy ore). The pulp should flow in a series of waves.
4. The amalgam (also on plates) is pasty and bright.
5. No oil or grease is allowed to come in contact with the mercury.
6. The amalgam on the plates is not allowed to get thick enough to scour off.
7. The gold is clean, not tarnished.
8. (Use care in handling cyanide, which is a deadly poison.)
9. If copper plates become discolored while pulp is flowing over them, the ore or mill return water may be acid. A cure for this is to add wood ash or lye, if available, or lime to the ore as it is fed to the stamps or ball-mill "

All this , back in 1926 for the so called "electroless copper plates".