SMI
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International Agency for Small-Scale Mining

Agence internationale pour les petites exploitations minières

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SMALL - SCALE MINING IN LATIN AMERICA

The present issue of the Small Mining International Bulletin deals with problems of small-scale mining in Latin America and its environmental consequences. Historically, Latin America has been a source for many of the precious metals required to meet the demands of the industrializing countries of Europe and later, North America. Traces of this established history in mining are still visible all over Latin America. For example, there are the widespread tin, silver and wolfram mines in Bolivia, the copper and gold mines in Chile, the exploitation of lead and silver in Peru, the extraction of coal, emeralds and gold in Colombia, and all over the Brazilian Amazon, where a huge number of garimpeiros still extract tons of gold from the rivers. In many of these countries a renaissance of small-scale mining has been notable throughout the last decades. The reasons for this are many: new finds of gold and other precious metals and valuable materials attracted a number of speculators, just like the gold rush in Alaska in the last century. The growing social tensions between different groups led many people to believe, that small-scale mining would be their last hope to making a living. Meanwhile politicians and planning staff try to determine the cost-benefit-ratio of small-scale mining.

On one hand small-scale mining contributes to the national economy in a diverse manner: As an important factor in generating income, in the training of personnel, as an efficient buffer for the labour market, thus alleviating the effects of structural adjustment programs. Small-scale mining helps to regionally internalize the costs and benefits of the operation. Small-scale mining offers working places with low specific costs and gives impact to the sustainable economic development in the region. Moreover, there are the secondary effects like rising mobility, circulation of money, local investment and demand for goods and services in the area which all contribute to rural development. On the other hand, small-scale mining involves a lot of the macro economy costs i.e. through the exploitation of a non-renewable resource and important costs arising from social tensions and the difficult problems involved in occupational safety and health. Another important cost factor of small-scale mining is that to the environmental costs. The present issue of the bulletin deals with the interrelations between these specific costs and the small-scale mining operation as well as these project strategies are trying to give a positive vision of the future even for small-scale miners and their environment.

The examples of problems and projects mentioned have been selected to give some hints on the special requirements of small-scale mining. Due to the economic, socio-cultural, legal and politically related problems of this sector, environmental measures are still a luxury for these small mining enterprises. Even more so, as it is very difficult for government organization to regulate and control small-scale mining and therefore, misuse of the environment is not normally punished.

Consequently the situation requires solutions which combine two different aims: on the one hand, optimal protection for the environment, and on the other, the necessity to elevate the economic results of the overall venture. Clearly spoken, every environmental investment needs economic incentives to be feasible for the small-scale miners. A gold digger who illegally works in the outback will pay not even a dollar for a machine or a technique which doesn't promise a two dollar return. This may sound very disillusioning, but the examples from the programs presented in this bulletin show that there are still a lot of possibilities to combine ecology and economy in small-scale mining.

by **Michael Priester**

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SMI Bulletin

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SMI is a non-profit organization dedicated to strengthening and supporting the small mining sector as an aid to rural social and economic development, especially, but not exclusively, in developing countries.

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Contributions in English, French, and Spanish on all aspects of small-scale mining, including up-coming events and new publications, as well as comments and suggestions, are welcome.

Requests for information on membership and subscription requirements can be addressed to SMI's secretariat at the above address.

Editorial -

WHITHER SMALL MINING INTERNATIONAL?

The recent history of small-scale mining (SSM) has been marked by a single over-riding fact: SSM has very few advocates in the upper echelons of the world of development aid and in the large mining houses. True, several bilateral and multilateral technical assistance agreements contain components addressing the small mining sector, but close scrutiny indicates these are less than comprehensive and even seem included as afterthoughts. One gets the feeling that SSM is viewed by many as an unavoidable nuisance which has to be 'tidied-up' in order to be properly cleared away.

This viewpoint is reflected in the lack of support for national and international agencies whose mandate covers SSM. In the past two years we have seen a severe cutback in funding to these groups with severe consequences. SSM desks and departments have been closed, scaled back or become dormant at several donor agencies and non-government organizations (NGOs) including UNDESD, BGR (formerly GTZ), CIDA, FINNIDA, ITDG and ATI.

The funding situation from the standpoint of development aid agencies does not appear likely to improve any time soon. Statements emanating from government and parastatal officials at a recent NGO consultation with CIDA left little doubt that development aid budgets are likely to remain depressed. Recent developments within the World Bank also indicate that SSM as a matter of policy will not take on increased importance despite an apparent groundswell of support as reflected in the pages of SMI Bulletin since it first appeared.

The work carried out to prepare the papers published here is testimony to the ability of the SSM community. The quality of the research cannot be doubted, yet we wonder what might be accomplished with more adequate levels of funding and support. For the time being however, it is important to continue with the development of meaningful technologies, policies and implementation strategies.

To this end, SMI has taken an active role in encouraging collaboration between groups working in similar geography or subject area. The SSM support community has shown interest in this idea but has been unable to muster the resources required. The funding crisis alluded to earlier has further exacerbated this situation.

The situation at SMI is now so severe that the operating budget for June 1, 1994 - May 31, 1995 is down almost 20% from 1992-93 levels and, without a replacement for the IDRC funded information system project, will fall a further 50% in 1995-96. Attempts to identify other sources have been unsuccessful. To paraphrase our VP, Calvin Pride, securing funds has been like using a bow and arrow to hit a moving target, a lot of effort with very little to show. Paradoxically, the more effort expended without reward, the less effective the organization will be in serving the SSM community.

SMI is at a critical crossroads and several key decisions need to be taken regarding its future. Moves have been initiated to begin decentralizing the organization in order to bring it more closely in contact with the SSM community. These moves will, however, accomplish more with the participation of SMI members, the SSM community at large and the various institutional entities involved in sustainable development worldwide.

The organization's needs are many and varied but most important is devising a way to ensure sustainable operations. Increased membership and advocacy helps,as do your ideas and suggestions on how SMI can best serve you! Only with this participation can the organization truly represent the sector and bring light to bear on its needs, aspirations and potential. If you think SMI is worth preserving, then give it your support!

Ecuador -

ENVIRONMENT PROTECTION IN ECUADORIAN GOLD MINING :

Experiences and Conclusions

Introduction

Beginning in the early nineteen-eighties intensive small-scale gold mining activities has taken place in the southern provinces of Ecuador. As a result of emissions of mercury and cyanide utilized in gold ore processing, the environmental situation has rapidly deteriorated. Whereas the emissions of cyanide have a relatively short-term effect, the mercury contamination presents a long-term problem, - a chemical time bomb.

The amount of mercury emitted by the approximately 100,000 small-scale gold-miners in Ecuador is estimated to be about 50 t per year and increasing. This situation causes growing concern to the Ecuadorian authorities and environmentalists.

In the South of Ecuador the three main gold mining areas are:

- Ponce Enriquez and Bella Rica
- Portovelo and Zaruma
- Nambija and Guayzimi

The more traditional mining communities of Portovelo and Zaruma in combination with the very densely inhabited cities nearby, offered the best possibilities for the necessary sensibilisation in environmental mailers and therefore conducted to the implementation of a project denominated 'Mining without Contamination'. The project is carried out as a cooperation between the Ecuadorian NGO 'Fundación CENDA' and the Swiss Technical Cooperation COTESU, represented by Projekt-Consult GmbH. The overall objective of the project is to reduce the environmental impact of small-scale gold mining in the 'Portovelo/Zaruma' area and thereby improve the health situation by implementation and diffusion of mineral processing techniques compatible to environmental needs.

Experiences

Initiating the Project

During the first months the main task was to inform the small-scale miners and the population about the objectives of the project. The start-up of the project led to different expectations. Some groups of miners expressed the anxiety, that the goal of the project would be to inhibit and close the mining operations, whereas the aspiration of environmentalist groups was, this should occur. A few people understood the intention to find an equilibrium between mining and environment, but expected immediate results. Therefore the main focus of the activities during the first year were confidence building measures and a widespread information campaign. The arrangement of two extensive public meetings in Zaruma and Portovelo with participation of about 5,000 inhabitants had a very positive effect.

Complementary to confidence building measures in general, specific activities were carried out. The Swiss Technical Cooperation realized this necessity and approved financing of the project 'Nutritional Help for Working Children of Portovelo'. Another activity was to initiate the implementation of a training-workshop in goldsmithing in Zaruma

Determination of Local Conditions

The existing topographic maps of the region proved to be inadequate for the purposes of the project. For that reason and in cooperation with the technical University of Loja the project began to create a detailed map 1:10000 of the region. Due to the number of mines and plants in the region (several hundreds) the mining inventory will be compiled in cooperation with the two schools of mines in Loja. Although numerous studies exists concerning the region, it proved to be necessary to carry out an up to date environmental monitoring to determine future strategies and the initial conditions. To carry out a initial health monitoring a international expert will be contracted. Portion of the health-monitoring (a investigation among children was carried out in cooperation with the director of a local school for hindered children (APANJEZ). For the determination of the socio-economic and socio-cultural conditions a national consultant was contracted. One of the most impressive results was, that about 50% of the miners are burning the amalgam in their home.

Technical Strategies

The best and sometimes only way to convince the small-scale miners, is to offer them alternative processing or working techniques, which provide economic advantages in combination with positive environmental effects.

In the region we find three types of small-scale miners:

- artisanal miners
- mines operated by informal societies with a intermediate degree of organization
- well organized mines and mining companies of the formal sector.

These operations require different strategies, which have to be designed to provide simultaneously environment and health protection and economic advantages.

The technology offered to the artisanal small-scale miners has to be locally manufactured low-cost equipment according to their financial possibilities. The infrastructure workshops and craftsmen able to produce the equipment has to be built up or has to be strengthened. The only equipment these miners can afford, are retorts for amalgam distillation. A retort adapted to the local conditions was designed and found to be able to recover about 98%

of the mercury. To fabricate the retorts a cooperation agreement was signed with the workshop of a local college.

For intermediate or well organized mines the promotion of retorts isn't the only possible strategy. The substitution of the amalgamation process by introduction of alternative technologies is preferable. The two possibilities to do this are: gravimetric concentration and smelting of the concentrate or improvement of the actual cyanidation process by percolation and introduction of agitation leaching. Although the well organized companies (those organized within the local chamber of mines) do not require technical assistance free of charge, they need a impetus to change their proved technical process. The largest mining company, a few months ago, began to adapt its processing plant to direct smelting, due to prior conversations with the technicians of the project. Field tests of equipment widely unknown in the region until now are ongoing (Centrifuges, Spirals, Agitation Leaching, etc.)

Social Strategies

The promotion of environment compatible equipment requires a specific marketing strategy. Marketing of the equipment must not start, before the implements are truly optimized, adapted to the local conditions and produced to acceptable quality levels. Later changes of the design will destroy confidence of the miners. Therefore the introduction of retorts began not earlier than one year after the start-up of the project. The promotion of alternative techniques to amalgamation will begin, when the knowledge about local mineralogical and geological conditions will be considered sufficient and the equipment will be proved success~full in pilot operations.

The introduction of new techniques will be facilitated. if the advantages of the techniques can be demonstrated in pilot plants in the district. Therefor the project signed several cooperation agreements with local mining companies to experiment technical innovations. The idea behind this strategy is that the rest of the miners will accept innovations more easily if local experienced miners do the promotion work.

Small-scale miners are not primarily interested in environmental protection. Even their own health problems are frequently not realized as results of inappropriate working techniques and toxic emissions. Sensibilisation and information on environmental and health risks are therefore important factors accompanying the implementation of new techniques. Environmental education has to take place simultaneously on all levels. For that reason a widespread environmental education program will be executed during this year.

Other incentives for adoption of environmental changes

The Ecuadorian Mining Law requires the presentation of Environmental Impact Studies by the holder of mining concessions and mill plants. These studies are usually prepared by local consultants. The terms of reference for such a study often exceeds the financial capacity of the concession holders, since the preparation of a serious study requires interdisciplinary teamwork. As a result the majority of miners choose one of the two following strategies:

- ignore the law and not carry out any study, or

- contract the cheapest consultant, often resulting in a study that may be faulty and consequently is refused by the respective authorities (DINAMI. DINAMA)

Following a suggestion of the Ministry of Energy and Mines and fulfilling multiple requests from miners, the project has elaborated the "Plan ECO+" The Plan .ECO+ (Collective Studies of Environmental Impact and Environmental Management) consists of interactions between the project, the Ministry and the Miners, and has advantages for each party. The great majority of mines and plants possess similar technical characteristics and are located in regions with similar environmental characteristics. This allowed the plans developers to encompass the whole region with a few collective studies irather than with hundreds of individual studies.

As these studies will be undertaken gratis, the miners have to sign a commitment to spend near half the price of an individual study, on environmental improvements in their own mines or plants which is a favourable situation for the miners. The Ministry of Energy and Mines accepted this proposal as a means to assuring the fulfillment of environmental regulations. The advantage for the project is that the NGO's undertaking the project, i.e. Fundación CENDA and Projekt-Consult GmbH, are in a position to influence environmental changes in the region.

Conclusions

In order to gain Credibility among Miners, Mining Authorities, Environmental Groups and the Population, and in order to guarantee the sustainability of a Mining Environmental Project, an integral strategy is required that includes:

Measures to build up confidence like technical, juridicial and medical assistance to the small scale miners.

Balance between the necessities of miners and of the community.

Ecologic alternatives that provides economic advantages.

Environmental education and sensitization of the populace.

Cooperation at all levels.

Achieve legislative and administrative changes in order to generate stimuli for changes in environmental management.

by **Felix W. Hruschka, Fabian Rodriguez G. and Carlos Salinas C.**

Felix W. Hrushka is program director of the Swiss funded project "mining without contamination" and is a former independent consultant and university lecturer in the field of international small mining and its environmental aspects.

Fabián M. Rodríguez Guerrero is the executive director of the CENDA Foundation, Loja, Ecuador. A consulting civil engineer in the provinces of Loja and Zamora, he is also a lecturer at the Technical University of Loja.

Carlos E Salinas Calero is a former Director of the School of Mines at the Technical University of Loja. At present he is the technical director of the "mining without contamination" project.

Colombia -

CONTROL OF POLLUTION FROM MINING WASTE DISPOSAL OPERATIONS

Introduction

Gold production in the Santandereana region accounts for approximately 1% of the national production, yet almost 70% of the mining population of the Santanderean municipalities of Vetas and California derive their sustenance from this activity. This labor represents a high risk for the health of the inhabitants of the metropolitan area of Bucaramanga, since the characteristic mineralogy of the deposits and the rudimentary techniques employed in the extraction process of the precious metals generate tailings contaminated with cyanides and mercury residues, which are disposed of in the Suratá river (Figure 1). This situation causes a serious deterioration of the quality of the waters of this river, situation that is seen affected by the changing eras of winter and present summer in the region. This presents a sanitary risk as the river's water is diverted by aqueduct for treatment, distribution and subsequent consumption by the inhabitants of the metropolitan area of Bucaramanga.

In response to this situation, in 1988, groups interested in managing the outlined environmental problem, among them the Ministry of Mines and Energy, MINMINAS, began the "Pollution Control Program for the Suratá river". An interinstitutional agreement was signed to define and implement the necessary measures to reduce, and/or eliminate the pollution risks that are confronting the affected population.

The present document relates the developed activities and the results obtained within the framework of the interinstitutional agreement, accomplishments which attest to the decisive participation of the groups involved.

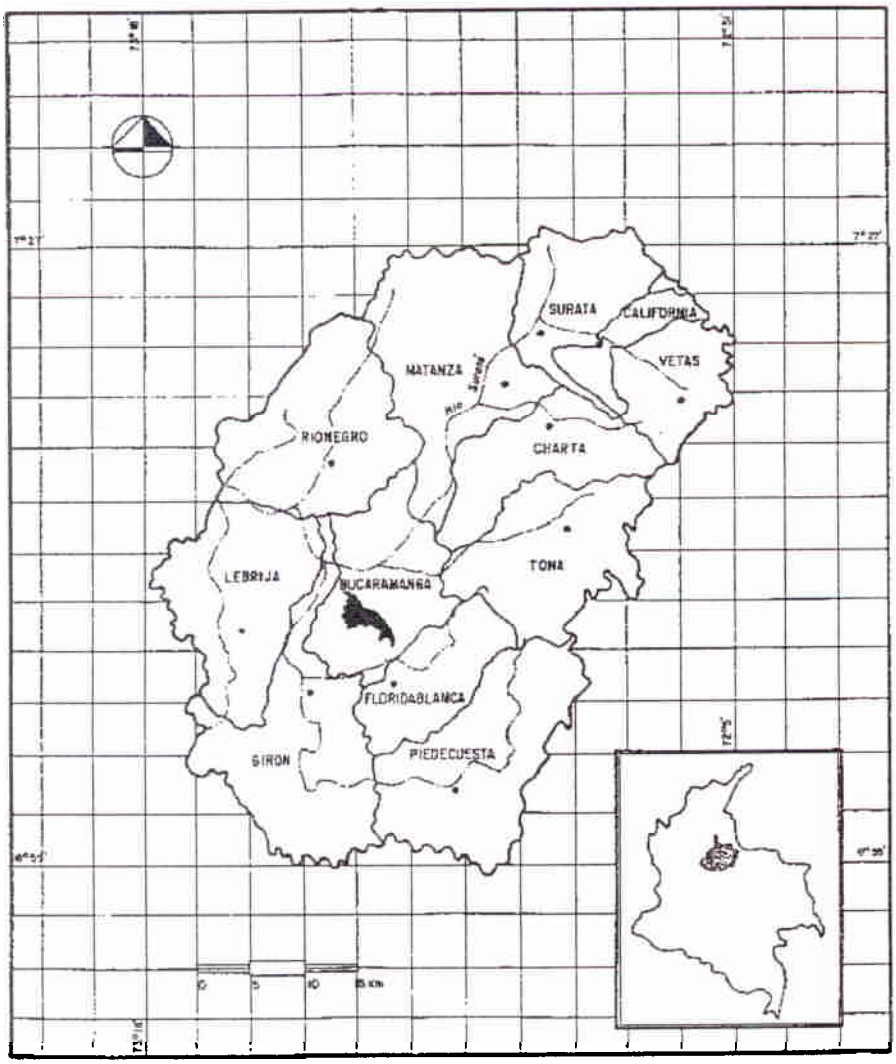


Figure 1. Map of Suratá river drainage basin showing relative locations of mining camps and metropolitan area of Bucaramanga

Accomplished activities

In accordance with the objectives of the agreement, to reduce and control levels of the pollutants, i.e. cyanides and mercury, through substitution or modification of the pollutant processes, the following activities have been carried out:

1. *Census and identification of the types of mining activity.* -This activity classified and identified the quantity, form of work, legal state and degree of technology of each one of the mining establishments that discharge their tailings into the Suratá river, noting over time, the constant increase in informal, low-tech mining practice.

2. *Diagnostic and socioeconomic study.* - The results of this study permitted to know the cultural and socioeconomic components of the community involved in the activity. It was established fundamentally, that approximately 70% of the inhabitants of the region derive their sustenance from the work in mining. Consequently, their par-

ticipation in the search for solutions to the conflict is indispensable.

3. *Characterization of effluents.*

- This study established the dimension of the problem, finding initially that the majority of toxic substances are due to the tailing discharges of the mining companies. Immediate actions were defined to reduce cyanide levels in the waterway, such as the implementation of a cyanide sand discharge programme aimed at monitoring the behavior of the pollutants in the Surat river.

4. *Formulation of Applicable operational alternatives.*

- From laboratory tests the optimum beneficiation process for value recovery, adjusted to the region's level of technological development, was postulated.

5. *Complementary actions.*

- Each one of the participating groups designed a work plan, inline with their specialization, focused on achieving the general objective of the Agreement.

EVOLUTION OF THE PROBLEM

Cyanide levels in the stream systems have been controlled in large part by the breakdown of each company's dumping operations, as a result of the Discharges Control Program mentioned previously.

By contrast, the situation with the mercury has deterorated over the last two years, representing a potential risk for the river dwelling population and especially for the largest user of the river, the metropolitan aqueduct of Bucaramanga. The use of mercury in the beneficiation process, by amalgamation in barrels, is common place in the region. During 1991, mercury concentrations levels of 10.6 g / L were recorded and during 1992, levels reached 23 g / L at the capture point, values that surpass the norm and disqualify the stream from domestic use. These values are found associated with highly turbid flow during the winter. Consequently, the pollution problem has given rise to the need for controlling this substance.

Mercury's relatively high density and low solubility generally favors its sedimentation in the bed of rivers. However, excessive grinding operations produce fines which adhere to clayey materials and remain suspended in the water column. It is for this reason that in harsh winter periods high mercury levels are noted, which in some cases disqualify the stream as a potable water supply.

On account of these problems activities have been suspended by some companies. The resulting unemployed personnel are protesting by installing and using amalgamation barrels in inappropriate places . Hence the previously mentioned situation is further exacerbated.

Because of this problem, it is necessary to take actions that help to evaluate, control and expertly establish the contributions of the mercury originating from the amalgamation operations.

Results

- Integration of knowledge bases of different groups seeking a common end, the conservation of the environment.

- Effective control of cyanide concentrations in the waterway, resulting from the implementation of the Discharge Control Program .

- Information transfer among the participating groups.

- Receptiveness of the mining community to the implemented Programs and sensitivity to the problem.

- Initiation of an Evaluation Program and Control of mercury tainted effluents

by **Martha L. Pinzón B.**

Ing. Martha Pinzón B., a geologist based at a regional department of the Colombian Ministry of Mining, MINMINAS, is in charge of the "Programa de Control de la Contaminación del río Suratá.

SMI ATTENDS INTERNATIONAL CONFERENCE ON DEVELOPMENT, ENVIRONMENT AND MINING

June 1-3, 1994, World Bank Auditorium

The conference was sponsored by the United Nations Conference on Trade and Development (UNCTD), the United Nations Environmental Programme (UNEP), the World Bank and the International Council on Metals and the Environment (ICME).

The objective of the conference as follow-up to the Rio Conference was to further the public debate on issues relating to the contribution of mining and the metallurgical sector to the development of environmental goals of society, most notably in developing nations.

The conference was presided over by the Honorable Henrique Brandao Cavalcanti, Minister of the Environment and the Amazon of Brazil. The meeting was attended by about 300 delegates from about 50 countries, including a sizeable number from developing countries. SMI participated in this meeting invited by and with support of the ICME to assist on a panel on Environmental Management in Industry. SMI Director Jeffrey Davidson was also present and made a presentation to ICME on SMI.

According to the Mining Journal, June 1994, perhaps the clearest message to emerge from the conference is that countries, both maturing and developing, with a significant mineral content to their economies are giving poverty and pollution elimination an equal place on the agenda.

The panel discussion on Environmental Management in Industry focused on Environment Management Systems (EMS). These systems are voluntarily adopted management systems, as result of growing public and corporate environmental awareness. SMI's contribution pointed to the fact that while the environmental performance of small miners, particularly those involved with artisanal gold mining, might be poor, this issue is a moot point for the informal miner. The small miner is driven by poverty and until that is addressed or tougher regulations implemented, small-scale mining will not go away. It

The Panel on Environmental Management in Industry. From left to right: Chair: George Miller, President, Mining Association of Canada; Henk Dahlberg, SMI, Hans Lim A Po, Senior Vice President Billiton International, The Netherlands and Michel A. M. Gisiger, Executive Vice President Societe Generale de Surveillance S. A., Switzerland.

was recognized that implementing EMSs for small-scale operators would be constrained by the scattered nature and unorganized structure of small-scale mining activity. Further, the scope for application is limited because EMS is part of a planning process based on management practices largely absent in small and medium-scale mining.

Issues recognized:

Informal or artisanal small-scale mining has a propensity for illegality driven by poverty of rural populations, exacerbated by inappropriate legislation, lack of alternative employment opportunity, training and education and the need to maintain subsistence incomes (UN Report E/C.7/1994/9). This creates major environmental, safety, health and social problems. The most serious impacts on the environment by informal gold miners are mercury pollution of the surface waters and mercury emission into the atmosphere. According to M. Priester of Project Consult GmbH, small miners consume world-wide between 300 and 500 tons/y of mercury of which about 50% is not recovered. Other adverse impacts on the environment include destruction of the substratum of the tropical rain forest, fish habitats and siltation of rivers.

Solutions suggested include:

1) Inventory of the magnitude and nature of the environmental impact by remote sensing followed by on site auditing as part of national, regional and interregional environmental monitoring programs. 2) Organizing of small miners in cooperatives and unions. 3) Establishment of an effective legislative/regulatory regime with designated areas and government hands-on role, including financial assistance, training and environmental protection. Partnerships of NGO's such as SMI, international development agencies, governments, national organizations such as the National Institute of Small Mines of India, cooperatives and unions such as FEDECOMIN and CEPROMIN of Bolivia, PSK of Indonesia and USAGAL of Brazil were proposed as effective means to support these policies.

During the following discussions one of the important conclusions was that standards for environmental protection should be the same for large and small-scale mines; the difference would be in the implementation. Another important conclusion was the need to encourage symbiosis of the small miners with large scale mining operations where possible, based on mutual trust and recognition of shared interests, facilitated by small miners unions, associations and cooperatives.

SMI announced its plans to organize a forum on environmental impacts of small-scale mining in the tropics, with emphasis on the tropical rain forest regions. The Ministry of Mines and Energy of Brazil offered to host this gathering in the State of Minas Gerais in the fall of 1995.

by **E. H. Dahlberg**

Henk Dahlberg is the current President of Small Mining International.

Brazil -

"Garimpagem" in Brazil: Problems and Solutions

In Brazil, informal sector gold mining is known as "garimpagem", mines as "garimpos" and the miners themselves as "garimpeiros". Although the scale of informal sector activity has steadily declined during the 1990s, it is probable that Brazil is still the country with the largest informal gold mining sector in the world; a census by the DNPM, the federal government mining agency, estimated the garimpeiro population at almost 300,000 in 1993. Total annual gold production in the garimpos is probably around 60 metric tons annually. The vast majority of garimpeiro activity is concentrated in Amazonia, where there are nine major goldfields, and many more isolated mines. They tend to be in relatively remote regions, far from even the most basic social amenities, and high rates of malaria and hard working conditions combine to ensure that the effective working lives of many miners are short.

Nevertheless, despite the social and environmental problems associated with garimpagem, it remains the case that the informal mining sector also brings important social and economic benefits. The very labour-intensive nature of the work, together with the remoteness of the mining areas, generates a large number of jobs not just in mineral extraction itself, but in the "ancillary" sector" of the garimpos: transport, fuel supply, entertainment. Unlike most areas of Brazilian society, there are also real opportunities for upward mobility within garimpos. It could also be argued that the cheapness, portability and simplicity of garimpeiro technology, often portrayed as crude by outsiders, in fact make it extremely appropriate to Amazonian conditions, making it possible to exploit deposits the formal mining sector would have rejected as uneconomic for a fraction of the cost.

The main environmental costs of gold mining are associated with mercury use, and malaria diffusion. Contrary to popular belief, garimpagem is a very minor cause of deforestation in the Brazilian Amazon, compared to ranching, lumbering and smallholder farming. Brazilian researchers have estimated that garimpeiros spill approximately the same amount of mercury that enters the North Sea annually, around 80 metric tons. Contamination also occurs through the release of mercury vapour as mercury/gold amalgam is burnt either at the mining site, or as gold moves along the trading chain. There is a theoretical possibility that mercury spillages could pose a major public health risk in the future, not so much for the garimpeiros themselves, but for the riverline communities downstream from areas of mercury use, who are dependent on fish for the basis of their diet.

Recorded cases of malaria in the Brazilian Amazon increased ten-fold between 1970 and 1989, and currently stand at over 500,000 a year. The boom in informal sector mining was probably the single most important underlying factor behind this increase. Mine workings filled with rainwater are ideal mosquito breeding grounds, and the high mobility of infected miners has done much to spread the disease. This can have a particularly devastating effect on previously isolated Indian populations who suffer garimpeiro incursions, such as the Yanomami, along the Brazilian/Venezuelan border.

Neverlheless, il would be a mistake lo concentrate only on problems at the expense of solutions. An increasing number of garimpeiro associations are coming to realise that mercury spillages also imply gold losses, and becoming interested in the possibility that cleaner mining technologies may also increase gold recovery rates. This economic imperative will become more powerful as time goes by and the deposits of easily available alluvial gold are exhausted, a stage which is already occurring in several goldfields. It is probable that simple, cheap attachments to sluices can both reduce mercury spillages and increase gold recovery rates, appealing to economic self-interest rather than a non-existent environmental conscience. Closed retorts have also been developed to recycle mercury when amalgam is burnt, and field tests of a number of devices have been carried out.

Most importantly, it appears that the next couple of years will see, for the first time, the setting up of a number of dedicated mercury analysis laboratories in the Brazilian Amazon, with regional Brazilian researchers and institutions being supported by the European Commission, and the Canadian and Japanese governments. This will give Brazilian Amazonians the opportunity to do something not previously possible: to monitor mercury levels in the environment, fish, and in human beings, throughout the region. As the consequences of many years of mercury spillages are not yet known, early warning of public health problems associated with mercury is essential if effective action to solve them is to be taken. There is now a real prospect that the technical and human resources to give such a warning will exist within Amazonia itself, ending the region's previous dependence on the outside world.

by **David Cleary**

David Cleary is an anthropologist with extensive experience of Amazonia. He is the author of "Anatomy of the Amazon Gold Rush" (Macmillan 1990). On secondment from the Centre of Latin American Studies, Cambridge University, he is currently directing a project financed by the European Commission aiming to develop cleaner mining technologies and set up mercury monitoring laboratories in the valleys of the Tapajos and Madeira rivers, Brazil.

Brazil -

Mercury Contamination Caused by Garimpos in the Pantanal Area

Introduction

Gold is won in many parts of the world by amalgamation with mercury. Since the 1980s, about 5000 workers have been employed in about 130 garimpos near Poconé, Mato Grosso, Brazil (Pasca, 1990). After the mining of the gold ore from protogenic deposits, the rocks are crushed and concentrated in centrifuges. Mercury is then used to amalgamate the gold particles. This makes it possible to separate the gold from the waste by gravitation. The waste from the amalgamation, contaminated with mercury, is collected in the tailings. In this way much mercury is deposited in the environment through the gold purification process (CETEM, 1989).

During the 1980s it is estimated that between 10 and 15 t of mercury were used in the region of Poconé (Lacerda et al, 1991; CETEM, CNPq, 1991).

To determine the actual behaviour of elemental mercury under tropical conditions and provide a basis with which to diminish the mercury contamination caused by garimpos, various groups of mercury species have been studied in water, sediment and air systems. Laboratory tests with tailing material had been carried out. Thus it was possible to evaluate the contamination effects on the environment and describe first transformations in the pathways of mercury in such tropical systems.

Materials and methods

In the studied area (Fig. 1), water samples were collected and filtered through 0.45 µm Millipore filters and stored in aged brown glass bottles. Sediment samples were also collected in brown glass bottles. After filtration, all water samples were treated with nitric acid and stabilized by cooling (T = 5° C).

Mercury was determined by atomic fluorescence spectrometry (AFS), using Brooks Rand Ltd. equipment. The Hg-O content was determined first by purging the water samples with argon. Next, the easily reducible fractions of mercury

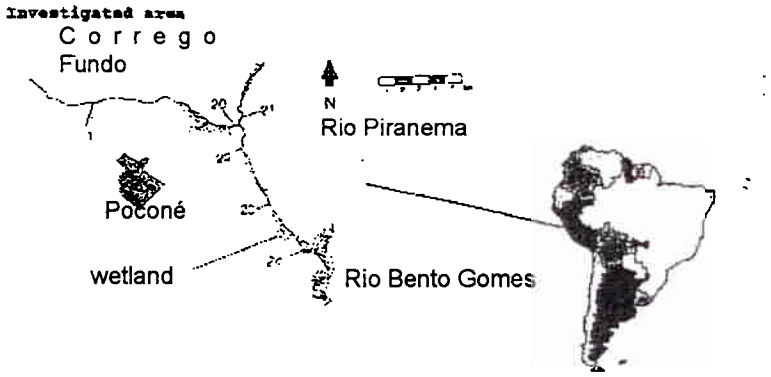


Fig. 1: Study area near Poconé, Mato Grosso, Brazil

were determined after reduction with stannous chloride. Finally, the samples were oxidized using a mixture of brominechloride, and the remaining fractions were analyzed after reduction with stannous chloride (Bloom, 1983; Brooks Rand Ltd.). The concentration of total mercury could then be calculated. The same procedure was used for the sediment samples to determine metallic mercury and the slightly reducible fractions. To determine the total concentration of mercury, the sediments were first digested in nitric acid (Hintelmann, 1989; Nagase et al, 1980).

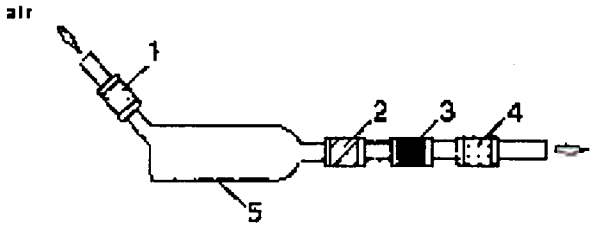
The equipment used to determine the rate at which mercury evaporated from contaminated tailings exposed to the air is shown in Figure 2. For determining the concentrations of organic and of metallic mercury in the vapour, respectively, a gold trap and a Carbotrap were installed in the heating device at the input point of the AFS.

Results and discussion

The investigations to determine the rate of evaporation from the dried surface of contaminated sediments showed that within four days at ambient temperatures (about 30 C), nearly all the mercury had evaporated from the sediment surface (Fig. 3). Only 0.3 % of this mercury had formed organic compounds. These organomercurials had evaporated completely soon after the beginning of the experiment.

The results of the analyses of water, sediment, and suspended matter from the Corrego Fundo and the Piranema River showed that the mercury contamination was higher than the natural background values, determined in the "Serra das Araras" National Park. The total concentrations in the water samples ranged between 18 and 160 ng/l with an arithmetic mean of 56 ng/l (n = 58), while the natural background content was only 25 +/- 0.9 ng/l (n = 3). Only 20 to 50 % of the total mercury in these waters is easily reducible. Metallic mercury, which can be extracted with gas, could only be detected in a few samples during the dry season. At the onset of the rainy season the concentration of metallic mercury in the water was significantly higher and showed the effect of leaching by rainwater from contaminated tailings (Fig. 4).

In the sediments, mercury concentrations ranged between 23 and 158 ng/g, with an ave rage of 74 ng/g (n = 58). The relative proportion of the easily reducible fraction averaged 18 % somewhat lower than in the water. Metallic mercury and its volatile organic compounds were below the detectable limit of 0.5 ng/g dry weight. One explanation for these results may be the adsorption of mercury and its compounds on the sediment particles.



1 gold trap for purification
2 quartz wool
3 carbotrap (reg. trademark)
4 gold trap
5 sediment

Fig. 2: Block diagram for the determination of the evaporation rate of mercury

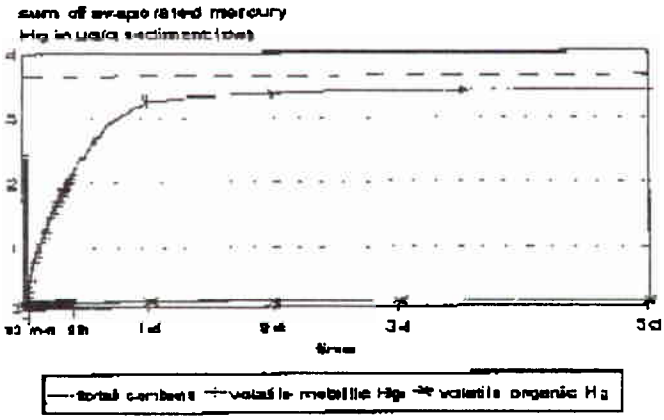


Fig. 3: Evaporation of mercury from soil surface, Hg concentration vs. time

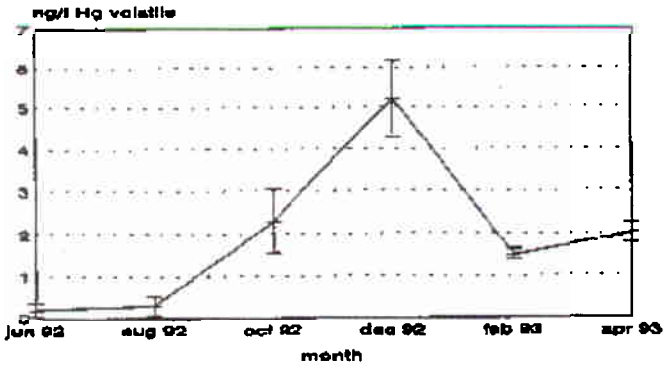


Fig. 4: Averaged concentrations of metallic mercury in river waters from Corrego Fundo vs. time

Conclusions

Comparisons of all the concentrations recorded for the water and sediment with similar values from other regions show that they are relatively low. However, they are higher than the na-tural background values measured in the national park "Serra das Araras", and it is possible that this mercury or one of the compounds it forms may present a hazard for one of the largest wet-lands in the world and its unique flora and fauna.

Probably, the mercury that entered the stream near the garimpos becomes immobilized in the sediment several kilometres away from the gold mining area. This would explain the failure to detect volatile mercury in the study area. These results also have shown, that the prohibition of introduction of mercury contaminated garimpo sewage into the rivers decreases the mercury contamination dramaticaly. However at the begin of the rainy season metallic mercury from contaminated tailings is transported with the rain water into the river system.

Tests with contaminated tailing material showed that the mercury evaporates nearly completely from the surface and may then be transported through the air to the Pantanal. This result of evaporation can also be a foundation for the development of equipments for decontamination of mercury contaminated tailing material from gold ganmpos for example by a controled evaporation before storing at tailings.

Our work contributes to the understanding of the main pathways for mercury in the tropical Pantanal system after determining mercury and its species in German contaminated areas (Hempel, M.; Hintelmann H.; Wilken; 1992). Its goal is the prevention of pollution and reduction of the problems caused by pollution in the past.

by **W.v. Tümpling jr., Dr. R.-D. Wilken, Prof. Dr. habil. J. Einax**

Wolf von Tümpling jr., analytical and research chemist, is working as an international operating independent consultant specialized in problems caused by mercury contamination.

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Chile -

Transfer of New Gravitational Gold Concentration Technologies to the Small Mining Sector of the Atacama Region

Introduction

The A.C.D.S.T. (Agence de Cooperation au Developement par les Sciences et les Techniques) is a Belgian NGO (Non Governmental Organization), that is collaborating with the University of Liège, especially in development projects with a scientific or technological content.

The NGO has identified, with the help of Chilean professors of the University of Atacama, the pollution problems caused by the indiscriminate use of mercury by the small miners of the Copiapd region, when they are processing gold ores.

The city of Copiapó is located 800 km north of Santiago and it is the capital of the third region of Chile. It is a mining region located in the southern part of the Atacama desert. There are found a number of small mines and plants whose main activities are related to processing gold and copper ores. This activity supplies income for an significant portion of the region's poor.

Actual processing technologies

The technology used by these small miners for processing the gold ores is the amalgamation process, that uses mercury for concentrating the gold. The ore is milled in a 'trapiche', also called Chilean mill, and the amalgamation occurs inside or outside the mill, above copper or silver plates covered by mercury. A subsequent flotation process permits the recovery of fine gold and sulfides.

The obtained amalgam is recuperated from the plates and then simply refined by fire. In that operation, most of the mercury's vapors escapes to the atmosphere and present a dramatic health problem for these workers. A significant part of the remaining mercury (that is not mixed with gold in the amalgam) escapes into the tailings and can then pollute soil and water (sometimes, the tailings are discarded directly into rivers).

New technologies

In the gold concentration field, the introduction of the centrifugal concentrators provided an alternative to the less efficient classical gravitational technologies (jigs, tables, spirals) for replacing amalgamation. The results of concentration tests with this kind of equipment in the laboratory of the University of Liège have given impressive results with various ores. Tests realized by the CIMM (Centro de Investigaclones Mineras y Metalurgicas) with a sample of ores of Copiapó's small miners provided high metallurgical recoveries and high grade concentrate.

Objective of the Project

The aim of the project is to further test these new gravitational technologies and to optimlze the processing parameters with the local ores in the University of Atacama laboratories.

The results of these tests will provide technical and economical data for the design of a small pilot plant. The construction of a demonstration purpose plant, with external funding, is projected too.

Conclusion

The mining sector is very important for the Atacama region. An important part of incomes are coming from it and the majority of the jobs, too. Unfortunately, the small mining sector uses old and inefficient technologies that are polluting the environment.

The transfer of new gravitational concentration technologies will help the small miners to raise their productivity and efficiency, but it will principally provide a solution to one of the important pollution problems of the region.

by **Denis Goffaux**

Denis Goffaux is a mining engineer based at the University of Liège, Belgium. He has spent two years working along with Atacama University, Chile, to promote new technology transfers.

SMI Bulletin, issue 9.

This issue will be released in **August 1995**. I invite all authors to submit articles for publication by **May 15, 1995**. In general, we accept submissions in the following formats: type written, double spaced with no more than 5,000 words, preferably in a 12 point sans serif font. Computer generated documents can be submitted on 3.5 inch diskette in Microsoft Rich Text Format, Wordperfect 5.1 or earlier, ASCII, Ami Professional 3.0 or earlier, or Ventura Publisher 4.2. For other formats, please contact the SMI secretariat for further information. Electronic documents may also be submitted as uuencoded e-mail to **michael@smi.minmet.mcgill.ca**.

Issue 9 will contain a SMI member directory, listing individual, corporate and institutional members. Please take the time to inform us of any recent changes to your contact information.

Venezuela -

ECOSYSTEM RESTORATION PROJECT, GUAYANA REGION

Background

The U.S. Department of Agriculture's Forest Service (USFS) is developing an expanded international program to promote the sound management and conservation of natural resources to meet human needs while protecting environmental quality. The USFS provides technical assistance in all aspects of forest based natural resource management as part of its international Forestry program. Goals of the program are to encourage and promote sustainable forest resource management practices, reduce natural resource degradation impending economic self-sufficiency, and strengthen the capacity of forestry and natural resource institutions, especially in tropical-subtropical developing countries.

The Corporacion Venezolana de Guayana (CVG) is an entity of the Venezuelan government with responsibilities in natural resource management, including mineral resource development, in the Guayana Region of Venezuela. The Guayana Region, located south of the Orinoco River, has a rich mining tradition, founded in its immense deposits of iron and bauxite, but also in its abundance in sand, gravel, building stone, non-metallic and rare earth minerals. However, it is the gold and diamonds that garnishes all of the recent attention. Not only because of the richness of the deposits, but also because of the tremendous environmental damage caused by uncontrolled hydraulic mining operations and the use of mercury amalgamation.

The image of Guayana to some is of destructive activity. Depletion of vegetation, production of immense excavations, degradation of soils, increased erosion, changing water courses creating mud flows, highly toxic chemical agents contaminating the waters and affecting the utilization of the hydroelectric potential of the region. In addition to the surface environment, uncontrolled mining in the area has created misery and problems for the human populations caught up in the race for fortunes. Shanty towns spring up overnight at rich strikes or "bullas", living conditions are horrible causing health problems. Mining waste water accumulates in stagnant ponds near settlements and become breeding grounds for mosquitos. Indigenous populations of wildlife and fish populations are depleted as the miners seek easy food sources in the isolated mining areas.

Finally, in the gold mining areas, the use of mercury for amalgamation of find gold was rampant. Wasteful use and handling has contributed tons of elemental mercury to the soil and river ecosystems of Guayana. As with many contaminants, once mercury enters the food chain, it continues moving. Mercury in tropical ecosystems carrying abundant organic loads proliferates the formation of methylmercury--the most lethal form of the poisoning known to living organisms.

It was into this scenario that CVG found itself when it inherited management and control of small mining operations about 4 years ago. Prior to that time, the Ministry of Energy and Mines controlled all mining development in Guayana. CVG was given the authority to develop the gold and diamond potential in the Guayana Region, but at the same time, they inherited the exorbitant task of bringing under control literally thousands of illegal miners operating small open-pit gold and diamond mines, most of the former contaminated with mercury.

Today In Guayana, things are changing. With the help of management and some very dedicated professionals, CVG has made good progress in controlling much of the area. Still, many areas remain isolated and with limited controls, but CVG remains committed to finding solutions which enable the development of the mineral resources while at the same time mitigating the damage to the tropical environment.

From the beginning, CVG realized the need for networking and further training for its personnel to handle the enormous task of managing the small miners in the Region. Because the USFS is known throughout the world for its interest and expertise in natural resource management, including minerals, CVG became very interested in working with them. Particularly, since the USFS has proven technical knowledge and demonstrated capacity to minimize and mitigate environmental impacts resulting from min-

ing, and oil and gas development–much of it with small miners.

In 1990, CVG-Tecmin engaged the USFS to train a group of mineral administrators in procedures and techniques for mineral exploration, development and production, while protecting environmental quality and other resource values through mitigation and reclamation measures. Out of that initial contact, CVG and the USFS negotiated the current project in Guayana Region.

Guayana project

Both the USFS and CVG have common interests in promoting environmentally sound mining and reclamation of areas disturbed bV mining. The USFS and CVG have identified the mutual desire to provide scientffic and technology interchange to promote reclamation and environmentally sound mineral development practices associated with small miners in Venezuela. The goals to be accomplished include (1) reclamation of areas previously disturbed by small miners, (2) transfer of procedures and technology that promotes more environmentally sensitive mining methods, and (3) an investigation of mercury in the tropical ecosystem in order to determine the extent of its impact on living organisms.

The following objectjves will facilitate the accomplishment of the goals of the project:

- Design reclamation strategies for the savanna and humid forest types. Develop sources of applicable plant materials and seed banks to support these strategies. Develop educational materials, present workshops and courses for CVG personnel to provide technology transfer in reclamation strategies. Adopt and use similar materials to present courses and workshop for small miners in mining areas.

- Design and implement environmentally sound mining systems that reduce sedimentation, protect water quality and associated aquatic ecosystems and improve recovery of gold while preventing mercury from escaping into the atmosphere. Include design and implementation of relatively simple, practical and low cost mining methods in combination with hydraulic monitors. Procedures to save the soil organic cap for later use in reclamation.

- Design investigation and plans to characterize the flow of mercury through the upper Caroni watershed and its effects on aquatic environments with applicability to other watersheds in the Guayana Region. Accomplish investigations through contracts and agreements with qualified institutions.

- Design investigations and plans to characterize sediment sources, production, flow and effects on aquatic ecosystems through the upper Caroni watershed. Accomplish investigations through contracts and agreements with qualified institutions.

- Test applicability of physical, chemical and biological methods such as creation of artificial wetlands, improved recovery techniques, concentrate processing, etc to capture mercury which is circulating in the environment. Accomplish through installation of test sites in a variety of locations representative of the region.

- Develop and implement workshops and courses for CVG technicians who administer management plans and work with the small miner.

- The USFS will facilitate talks with World Bank and other international financing institutions in order to obtain financing for continuation of the project and its long term commitments.

Accomplishments to date

- Mercury team specialists obtain background samples from waters and sediments within the Caroni Watershed in order to establish background levels of mercury (1993).

- USFS-CVG sponsored International Conference on Mercury in Tropical Ecosystems, held in Puerto Ordaz, Venezuela to inaugurate mercury investigation. Discussions to include the human element into the mercury study (1993).

- Mining team specialists travel to Guayana to evaluate the type of technical mining problems that occur and make recommendations to CVG management (1993).

- Reclamation specialist team travel to Guayana to evaluate the reclamation problems and initiate strategies and recommendations to CVG management (1993).

- Initial meeting with World Bank officials to gauge interest and determine process, information, etc needed for potential loan applicants(1993),

- CVG field investigation of native plants specific for revegetation and establishment of test plots, herbarium and nurseries in the mining zones to refine reclamation techniques (1993).

- University of Central Venezuela 's, Dr Armando Ramirez, put under contract with USFS to lead counterpart CVG mercury investigators (1994).

- CVG laboratory personnel receive technical training through USFS/USGS in mercury analysis for water and sediments in Denver, Colorado (1994).

- CVG mercury specialists begin evaluating possible mercury laboratory sites at Tumeremo, Puerto Ordaz, *Guri, Ciudad Bolivar and Hato Gil (1994).*

- CVG and UDO (technical university) begin talks to reactivate past cooperation in order for University to provide physical space for a dedicated mercury analysis laboratory (1994).

- UNEXPO (technical university) contracted by CVG to build drag scraper shovel prototype adaptable to portable winch system. Pick-up cable system introduced by USFS Equipment Development Center. Both systems being constructed to determine their applicability in reclamation work specifically, saving the organic topsoil prior to mining for later reclamation (1994).

- Joint USFS reclamation/mining team specialists travel to Guayana to begin demonstration and training of methods, procedures and technologies for mining/reclamation to mining cooperatives. Demonstration of gold recovery equipment and techniques to show small miners how achieve more recovery of gold with less destructive consequences (1994).

- CVG management sends agronomist to U.S. to receive specialized training in degraded land reclamation techniques and strategies under the tutelage of the USFS specialists (1994).

- Selective video-taping of the Caroni River drainage at low water as part of the process in selection of sediment and water sample sites for upcoming field season (1994).

- Joint USFS and State Department MOU to provide limited funding for training of technical personnel in analytical methods for determining methyl-mercury content in blood, urine and hair (1994).

- Establishment of a repository for all technical information obtained from USFS and other sources in the form of technical magazines, professional journals, video tapes, books, etc (1994).

- Begin development of a field guide in reclamation/mining methods and techniques (1994).

- Begin talks with national government about integrating CVG Guayana Region reclamation strategies into national plan for reclamation and reforestation (1994).

- USFS makes presentation to Consejo Nacional de Fronteras concerning Forest Service's Community Assistance Program and one of its programs now being supported: American Dentists for Foreign Service (1994).

- USFS selects medical doctor and bioanalyst to receive Forest Service sponsored training at the University of Rochester, NY, in analysis techniques for methylmercury in humans (1994).

- World Bank/USFS project specialist to Venezuela to explain process to apply for GEF II funding for biodiversity-related projects (1994).

- CVG-USFS training session at Tumeremo for CVG field camp personnel in mining/reclamation methodologies, etc (1994).

- CVG-USFS sponsored trade show at Icabaru to attract national and international equipment manufactures of environmental products and mining equipment adaptable to the small miner's situation and resources (end of 1994).

by **John Gutierrez**

John Gutierrez is a mineral examiner with the USDA Forest Service. He is currentlyserving as project manager on the ecosystem restoration project.

Colombia -

Methods to Improve the Yield and Reduce the Environmental Impact of Small Coking Works in Colombia.

The production and use of coal is an important economic factor for Colombia. Besides the large scale prodiction of coal in the regions of Antioquia, Guajira, Cesar and Norte de Santander, coal is produced by small mining comapnies in the provinces of Cundinamarca and Boyacá. In contrast to other areas worked by small coal mining companies in the province of Cauca, the coal in Valle del Cauca and Antioquia possesses good cooking properties which has led to the provinces of Cundinamarca and Boyacá becoming the most important regions for colombian coke supply. The only other coke production in Colombia occurs in the province of Norte de Santander.

The total coke production of the regions of Cundinamarca and Boyacá is estimated at 450,000 tonnes after a research study undertake in 1990. Of this, approximately 140,000 tonnes is due to the small producers of the regions. To produce coke on a small industrial scale, two different type of ovens are used - the Pampa oven, a half open oven based on the principal of the Schaumburger oven, and the Colmena oven, a free standing basket oven. In total there are approximately 510 Colmena ovens and 100 Pampa ovens in the two regions.

The coking process in a Pampa oven takes place in an approximately 10m long by 3m wide and 2m deep ceramic brick lined basin with a capacity of 50 to 100 tonnes of coal. The oven is charged with crushed coal after being started with the help of firewood on air racks beneath. The coal layer is covered with non-combustible earth or ash. The cooking process commences from the bottom to the top and takes 10 to 20 days according to the oven capacity and the oven rest temperature. The heat necessary for coking comes from a partial burning of the input coal and the resulting expansion gases produced. The partially burnt expansion and coke gases leave the through a gas escape opening and through numerous places in the cover. Before extraction, the coke is sluiced with water.

By contrast, the Colmena oven uses a free standing ceramic brick lined basket with side opening doors (for extraction of the coke) and a hole which serves to charge the oven and release the coke gases. Commonly, a number of Colmena ovens are built (up to six) in a single or double battery of ovens. In operation, new coal (3 to 4 tonnes) is introduced into the still hot oven in the last coking cycle. For this purpose, the coke extraction door is closed with a ceramic brick wall. The latent heat in the oven leads to gas development and self combustion. The necessary coking heat is reached by a part of the coal and resulting coking gases burning with the help of air entering the oven through holes in the oven door. The partially burnt gases are realeased through the hole. The entire coking process lasts 2 to 3 days. Before extraction of the coke, the oven is extinguished with water. The extraction is then carried out manually.

The coking efficiency reaches 50 to 55%, depending on the procedure used and the coal quality. Per tonne, feed coal must have a gas content of approximately 1,5000 Nm3. Combustion gases include dust, CO2, H2O and SO2 and combustible components such as H2, CO and partially burnt hydrocarbons, with a heat content of 1,000 kcal/Nm3. The environment in the neighbourhood of the coke ovens is not insignificanntly effected by these gases. Apart from the omnipresent smoke and dust there are hydrocarbons emitted (Benzol, Toloul, Xylol, polycyclic aromantic hydrocarbons, Benzo(a)pyrene) which are a cancer danger for the neighbouring population.

The increase in the number of small coking works in the regions of Cundinamarca and Boyacá pressingly demands measures to prevent the environmental threat previously mentioned. Small-scale producers need solutions which are technically and socially acceptable yet economically affordable. Corresponding solutions must take account of the existing coke oven technology, locally available resources and

financing from non-speculative investors. The method selected here deals with secondary combustion of the exhaust gases of Colmena ovens to reduce the environmental threat and at the same time to utilize the energy content of the gases.

To achieve this aim, the following process will be used; the exhaust gas from a coke oven battery will be directed over the collection channel of an comb(sic) afterburner. Through installation of optimal comb parameters, the gas will be completely burnt, and dust removed (using dust cyclones) before release into the environment through a chimney. The heat produced by the after burning will be used to produce steam with the help of boiler to power a small steam turbine. The steam turbine drives a generator which directs power to the local electricity network. The steam exiting the turbine will be condensed in a cooler. The condensate returns as feed water back to the boiler. An increase in coke quality and quantity will certainly be obtained because of the resulting easier control of gas flow in the Colmena oven.

Preliminary studies in Germany and Colombia concluded that the sale of the electricity generated by the process would amortise the cost of the plant in an acceptable time frame. Currently a feasibility study is underway for the development on 0.8 MW pilot plant in the region of Samarca in the province of Boyacá which is expected to be completed by the end of 1994.

by **Heino Vest**

Heino Vest, is an independent mining/metallurgical engineering consultant, specialized in recycling technologies and energy utilization for industrial processes. This reported study was carried out for Project-Consult GmbH.

Brazil -

Semi-precious Gem Mining in Southern Brazil: In view of the environmental aspects

Ametista do Sul, Planalto, Rodeiro Bonito, Frederico Westfalen and Trinidade do Sul are all communities in the north of the Brazilian state of Rio Grande do Sul, where amethyst and agate are mined on a small scale. The mining tradition goes back about 150 years. Around the middle of the twentieth-century, an intensive development in underground mining began. The mining operations concentrate on a flatly layered, 3-4 m thick basalt horizon, in which there are numerous, up to 3 m thick geodes of crystal with amethyst and agate. Where the topography exposes the horizon, parallel drifts are opened, enabling the irregularly scattered druses to be struck with pick and hammer.

At the present time, there are around 5,000 "garimpeiros" (small-scale mining people) and approximately just as many tunnels, 7-20 of each forming a "garimpo" (a mine). A garimpo belongs to a working-cooperative formed of landowners and owners of mechanical equipment (electricity supply, compressors, percussion drills, conveyor barrows etc.). Without any additional social insurance security, the garimpeiros work on a 40 % participation sharing of the stones' selling price to dealers or exporters.

Constitutional rights of 1988 and the law on garimpo activities made in 1989, permitted the garimpos to operate lawfully after concessional application had been made the Brazilian mining authority DNPM. Concessions involving bigger areas are preferably granted to cooperatives rather than single individuals.

In 1990, garimpeiros in the region united to form the "Cooperativa dos Garimpeiros do Medio Alto Uruguai" (COOGAMAI), with its headquarters in Ametista do Sul. A year later, and for the first time in Brazil, the DNPM issued the COOGAMAI as representatives of the mining people, a mining grant termed over 5 years, for 83 concessions in an area of approx. 16,000 hectares. The mining grant is valid when sanctioned by the environmental authority responsible for Rio Grande do Sul, FEPAM. Upto now, the cooperative has only received the environmental authority's provisional consent, and therefore within a year, an environmental assessment is to be presented. The authors are at present, under contract with the German "Bundesanstalt fur Geowissenschaften und Rohstoffe" (BGR) [Federal Agency for Geosciences and Raw Materials], in the process of assisting the COOGAMAI with the preparation of the required report.

Preliminary investigations have so far shown that the actual extraction and its resultant further processing impairs the environment in the following ways:

Impaired area of the environment	Resulting from
land-surface	road building for transport access to mine, spoil piling, rock/slope slides, unsealed pits
atmosphere	blast fumes, drill dust from underground mining
ground and surface water	mine waste wash-outs and direct impairment of watercourses, drainage and depositing of acids used in processing, oil-soaked dust sludge etc
flora	the flora of a protected forest area in the south of the region has become affected by the mining developments. Also in other areas on the less considerable scale, there are signs of mining pollution impairment to local vegetation, e.g., woods etc.

mineral resources disturbed by the mining itself (disruption of an irreplaceable resource), losses through the unsystematic and incomplete utilisation of the deposits.

eco-system again disturbances to the protected forest area in the south of the region.

human damage to human health through no, or inadequate working safeguards.

On the one hand the damage to the physical environment can be kept relatively simply and cheaply within limits by improved mine planning, reforesting, and better waste disposal for the materials used in the processing procedure. The social environment however, poses on the other hand manffold problems and tasks. What count here are occupational safety measures, both at the mine face and during treatment processes, and the need to develop an awareness for environmental questions.

Dry drilling down at the mine face with its violent amounts of dust poilutim and noise, the ignition of blasting powder with simple short-drcuit fuses, and cramped pick-work in low gangways are all health hazards. Bronchial and hearing problems (pneumoconiosis, deafness) result, as well as numerous and sometimes fatal electric shocks, abrasions and cuts. Although the introduction of new machines and methods of mining promises better working conditions for the garimpeiros theoretically, such an imposed solution is unrealistic on the grounds of the unwillingness of the garimpo owner, the lack of capital, and the individualistically styled work-sharing structure. Much more, the consequent use of personal safety-equipment (helmet, protective goggles, dust respirator, noise mufflers and rubber boots), promises high–effectivity at a low cost.

At the processing stage there are considerably inadequate safety precautions involving sawing, grinding/polishing, dissolving mineral crusts and determining the agate colours. Cuts caused by sawing, grinding of the hands caused by the abrasive band grinding machines, cauterization and burns by ignition of sawoils are the most frequent injuries. As well as the use of simple personal protection (especially gloves, protective goggles), strict adherance of the safety regulations is absolutely essential.

The garimpo owner, the owners of the processing outfit, and especially the co-operative should all bear responsibility for four various forms of intervention: the material provision of protective equipment; the nurturing of an awareness among the garimpeiros in matters of environmental protection and personal safety; the definition of working procedures and the effective execution of controls and sanctions where there is non-compliance.

Such responsibilities can only be initiated and maintained in the interests of the mining people, where the cooperative is equipped with sufficient personnel, financial and material means.

With a united effort on the part of all concerned - from the garimpeiros to the government agencies - the opportunity now exists in Rio Grande do Sul to develop and operate environmentally acceptable models in the mining and processing sector. For its part, the COOGAMAI can continue with its forerunner role, just as it did with the legalising of small-scale mining in Brazil.

by **B. Grimm, M. Priester**

Beate Grimm, geologist, specializes in environmental aspects of small-scale mining and is involved in this capacity with the semi-precious gem mining project in Southern Brazil.

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CALENDAR OF EVENTS

The Cordilleran Geology and Exploration Roundup
7-10 February 1995
Vancouver, Canada
Details: British Columbia Chamber of Mines
840 West Hastings St.,
Vancouver, B.C. V6C 1C8
Phone: (604) 681-5328

International Resources Law II: A Blueprint for Mineral Development
13-14 February 1995
Hyatt Regency Hotel, Denver, Colorado
Registration: Rocky Mountain Mineral Law Foundation
7039 East 18th Ave.
Denver, CO 80220 USA
Phone: (303) 321-8100
Fax: (303) 321-7657

Asia Metal and Mining Summit '95
27-28 February 1995
The Regent, Singapore
Registration: IBC Technical Services Ltd
268 Orchard Road, #16-01/02 UOL Bldg, Singapore 0923
Phone: (65) 732-1970
Fax: (65) 733-5087

Prospectors and Developers Association of Canada, 1995 Convention and Trade Show
4-8 March 1995
Royal York Hotel, Toronto, Canada
Registration: Congress Canada
191 Niagara Street,
Toronto, Ontario M5V 1C9, Canada
Phone: (416) 860-1772
Fax: (416) 860-0380

The Pan Asian Mining Congress '95
Emerging markets, prospectivity and regulation in key mining destinations
13-15 March 1995
The Marina Mandarin Hotel, Singapore
Registration: AIC Conferences Pte Ltd
51 Anson Rd, #09-55, Anson Centre,
Singapore 0207
Phone: (65) 222-8550
Fax: (65) 226-3264

California Mining Association Annual Meeting
15-17 March 1995
The Inn at Napa, Napa Valley, USA
Details: Kathleen Creason
California Mining Association
1 Capitol Mall, Suite 220,
Sacramento, CA 95814
Phone: (916) 447-1977

Investing in the Americas
27-29 March 1995
The Sheraton Bal Harbour Resort, Miami, USA
Registration: Florida Adventures Int'l, Inc.
9100 S. Dadeland Blvd., Suite 702
Miami, Fl 33156 USA
U.S. Phone: 1-800-670-3111
Canada: 1-800-282-7469
Int'l. Phone: 1-305-670-3111
Fax: 1-305-670-4518

International Round Table on Artisanal Mining
17-19 May 1995
The World Bank, Washington, USA
Details: Attendance by invitation. Contact SMI for further information.

African Mining ,95
7-9 June 1995
Details: The Conference Officer
Institute of Mining and Metallurgy
44 Portland Place, London W1N 4BR, UK
Phone: +44 171 580 3802
Fax: +44 171 436 5388

International Conference on Industrial Minerals: "Investment Opportunities in Southern Africa"
21-23 June 1995
Mulungushi International Conference Centre, Lusaka, Zambia
Registration: Sandfor Mambwe
Conference Organising Secretary
The University of Zambia School of Mines
P.O. Box 32379
Lusaka 10101, Zambia
Phone: 290746
Fax: 293164
Telex: ZA 44370 UNZALU

Small Mining Busines in the North-West Russia: International Conference and Exhibition
19-23 September 1995
Karelian Research Centre, Petrozavodsk, Russia
Details: Dr. Vladimir Shchiptsov
Conference Officer
185610, Ptrozavodsk
Pushkinskaya str. 11, Karelia Russia
Phone: (814) 72753
E-mail: GEOLOGY@KARELIA.IAS-NET.COM

International Conference on Relatively Sustainable Energy and Mineral Resource Development in Developing Countries
8-10 November 1995
Hat Yai, Thailand
Details: Asst. Prof. Dr. Rotchanatch Darnsawasdt
Department of Mining and Metalurgical Engineering
Faculty of Engineering,
Prince of Songkla University,
P.O. Box 2, Hat Yai 90112
Thailand
Phone: +66 74 212 897 xtn. 2235-2236
Fax: +66 74 212 802/805

Global Conference on Small/Medium-Scale Mining and Panel Deliberations-Evolving Appropriate Strategies of Development
17-23 January 1996
Details: Mr. S.L. Chakravorty
Convenor
National Institute of Small Mines
6A, Dhakuria Station Lane,
Calcutta-700 031 India
Phone: +91 33 473 9542
Fax: +91 33 473 9542;248 6604/1620
or
Mr. V.S. Rao
The Tata Iron and Steel Co. Ltd.
TATA Centre,
43 Chowringee Road,
Calcutta-700 071 India
Phone: +91 33 247 7540
Fax: +91 33 247 6993

Fourth International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production.
7-11 October 1996
Details: Prof. R. Ciccu
Dipartimento di Geoingegneria e Tecnologie Ambietali (DIGITA)
Universitá degli Studi di Cagliari
Piazza d'Armi
09123 CAGLIARI, Italy
Phone: +39 70 2000317/2000320/2000322
Fax: +39 70 272031

BOOK REVIEW

Tools for Mining, Techniques and Processes for Small-Scale Mining by Priester, Hentschel & Benthin, A4, 537 pages, ISBN 3-528-02077-6 Published by Deutsches Zentrum Fur Entwicklungstechnologien. $95.00 (?) Spanish edition: Pequeña Minera-Técnicas y Procesos, ISBN 3-528-02066-0

Tools for Mining is one of the most valuable books ever to have been published in the field of small-scale mining. It consists of five overviews and 19 technical chapters covering 126 equipment groups divided into five sections: Analysis, Underground Mining, Surface Mining, Beneficiation and Energy,

Each of the main sections starts with an introduction outlining definitions, problem areas, environmental and health risks, and organisational advice. The environmental section is especially strong with emphasis applied to estimating the impact of using each of the different types of technology.

For each of the 126 equipment groups described under separate headings, technical and economic data are described and manufacturers listed. These are followed by summaries of the operating principles and conditions of application. Each is further considered in terms of suitability for small-scale mining and examines possibilities for manufacturing at the local level. Photographs, drawings and simple dimensioning aids are included to assist local manufacture.

One of the author's objectives was to merge the historical, modern and traditional elements of mining, and they have done a great job in presenting information on hundreds of items of mining equipment. These vary from the very old to the new, as shown in numerous fascinating engravings interspersed with photographs of machines in current use.

A number of devices still used in Bolivia and Colombia testify, to the rich legacy of techniques that come to us from the past, before the industrial revolution of steel and combustion engines. Machines then used levers, pulleys, wedges, axles, screws and inclined planes, and these are illustrated in abundance, together with examples of adapting everyday mechanical objects like car axles, gear levers and a truck chassis being used for shaft hoisting.

The work is very visually communicative, with a large number of diagrams showing comprehensive detail, and is something engineers will want to examine at some length. It requires the reader to possess some technical knowledge and be able to understand and interpret the sketches and technical drawings which are offered at a relatively high level. All data presented are organised in a well-structured way with clear labels and consistent headings.

Small-scale mine operators will do well to examine this work carefully for tools to adapt or modify to make their mining more productive, and there is so much thought-provoking detail that all will find something new. This is an important work, which will surely stand the test of time.

Mining engineers have a tradition of sharing their information which the authors continue admirably. They have used sound communication skills to bring the valuable gift of knowledge to small-scale mining, and the world is a better place for it. One thing I noticed were the smiles on the faces of many of the miners beside their devices - which says much about the pride that they have in their work and the usefulness of the tools.

This important work meets a key technological need with accuracy and clarity. It is somewhat like a shortened version of Peele's Mining Engineers' Handbook and represents technology transfer par excellence.

Review by **Nicholas Hunter**, Hunter Mining Consultants Ltd Bath, England.

GEMS AND NUGGETS

Upcoming Conferences

In the lead up to the **Fourth World Conference on Women** in Beijing, China, 4 - 15 September 1995, SMI has been working with UNIFEM and IIED to ensure that the issues pertinent to women in SSM are noted and addressed in the relevant forum.

Any reports or studies on the issue of women in SSM, their roles, needs and achievements would go a long way in garnering support for this critical subsector. For further information, contact:: Marilyn Carr International Institute for Environment & Development 3 Endsleigh Street London, WCI H ODD England, UK (+44171) 388 2117 Fax: (+44171) 388 2826 Telex: 317210 BUREAU G or Editor, SMI Bulletin (contact information on inside front cover).

In preparation for the **World Summit for Social Development** in Copenhagen, Denmark, 6 - 12 March 1995, UNESCO is is hosting '**Audience Africa**', a seminar to "pinpoint Africa's priorities as identified by African's themselves". We look forward to the outcome of these gatherings as regards the status of micro enterprise and SSM.

Directors News

SMI offers its sincere gratitude and best wishes for the future to Dr. Richard Notstaller who this year resigned from the Board of Directors of SMI.

SMI this year welcomes five new Directors to three year terms on the Board. The new directors are Ms. Diana Lee Dalton, formerly of the United Nations now in private practice in Nova Scotia, Canada. Dr. Bharat B. Dhar, Director of the Central Mining Research Station in Dhanbad, India. Mr. John Holloway, a consultant on SSM development issues, from Zimbabwe, Mr. Nicholas Hunter of England and Mr. Giles Munyoro, President of the Small Scale Miners Association of Zimbabwe.

In 1995, the terms of seventeen, 17, members of the board will conclude. Members are advised that if unable to attend the AGM, it is possible to nominate a person to the Board and vote on items on the agenda. Nominations and/or proxy votes can be submitted by mail to the SMI secretariat as indicated on the inside front cover.

Work Under Way

Parrots in Peril expedition from England is in Ecuador carrying out ornithological survey of southern Ecuador to assess the status of threatened endemic parrot species. As a part of this study, the group conducted an investigation (1992) of the effects of small scale mining activity on the Podocarpus National Park and a contamination study of the nearby town of Nambija.

In follow up work ,the group is now in Ecuador and they have been put in contact with an SMI member, Sr. Joaquin Garcia Doltz. SMI hopes to collaborate further with this expedition in carrying out a census of the SSM population in the region.

The **SSM Information System** project has progressed in fits and starts over past couple of years and is nearing release. The system will operate over the internet and will provide access to bibliographies, documents and raw data pertinent to SSM. SMI and NISM (India) the systems developers, welcome enquiries parties interested in contributing data and documents or in becoming involved in testing the system. More information is available from the Information specialist, SMI or Mr. P.P. Chaudhuri, NISM, 6A Dhakuria Station Lane, Calcutta 700 031, India, Tel/Fax: +91 33 473 9542

Current Opportunities

Nigeria - Technical assistance being sought by Kaolia producer. Interests are in improved mining processing technologies, equipment sourcing and marketing. Willing to explore partnership opportunities. Contact: Mr. A.B. Ekemita, Managing Director, Ekemita Nigeria Limited, 28 Agenebode Road, P.O.Box 548, Auchi, Edo-State, Nigeria, Tel: 057-200326

Ghana - Partners and Suppliers being sought by small enterprise industrial complex. Needs are related to agro-geology, soil remineralization and related fields. Contact Ahmed Kwame Owusu, Managing Director, Ako Nana Industrial Complex, P.O. Box 22, Akrokarri - Adansi/West, Ghana.

Central African Republic - Financing assistance being sought by artisanal diamond producer/trader. Contact Mr. Oumarou Mamadou Mewaki, Artisan-Or-Diam, B.P. 369, Bangui, Central African Republic, Tel: (236) 61:20:77

Russia - Private engineering and consulting firm with expertise in mining/geological information systems is interested in international joint venture partnerships. Contact: Mr. Alexander Mikhailov, President, MIR Company, Foundation "D&E", Pyzhevsky per., 3 Moscow 109017, Russia, Fax: 7-503-956 3586,
E-Mail: root@gold.gins.msk.su.

Jamaica - Aggregate producer seeks assistance in procuring used capital equipment. Also opportunities for joint venture partnerships in developing high purity/high brightness limestone and dimension stone prospects. Contact: Mr. Lawrence Henry, Director, Geological Survey Division, Hope Complex, Mona, Kingston 6, Jamaica, Phone: 809 927-1936-1940

Guyana - A gold miner seeks party to invest in or join in a joint venture for operation of the mine. Contact: Morris Sawh, North American Machines and Spares Inc., 105 Court St., Suite 410, Brooklyn, NY 11201, Tel: 718 260-9300 or Fax: 718 875-5398

Guyana - Gold mining operation seeks investors and equity partners in order to expand to hydraulic mining operation. Contact: Mr. R. Ali, IMO Guyana Inc., 1 Farraday Lane, Rm. 2B, Palm Coast, FL 32137, USA, Tel: 904 445-9885 or Fax: 904 446-2230.

Technology News

Ausmelt Limited was chosen to provide a plant to treat 72 tonnes per annum of anode slimes, a by-product of electrorefining copper, to recover precious metals, to Hindustan Copper Limited operations at Ghatsila in India. The plant will produce approximately 6000 kg of metal containing 91% Ag and 6.0% Au per annum. For more information contact Peter King, Executive Director, Ausmelt Limited, 12 Kitchen Road, Dandenong, 3175, P.O. Box 1003, Victoria, Australia, Tel: +613 794 6200 or Fax: +613 794 9411 or Alan Smith, General Manager, Ausmelt Technology Corporation, 1331 17th Street, Suite M103, Denver, CO 80202, Tel: 303 295-2216 or Fax: 303 295-7605.

The USDA Forest Service project in Venezuela, described earlier by John Gutierrez, field tested an inexpensive computer program for studying the effects of multiple small miners contributing sediment to drainages. The program, called SEDCAD, is available from Service Software Design, P.O. Box 706, Ames, Iowa 50010, USA, Phone: 515 292-4115. The project team has also produced informational brochures with technical specifications and costs for the manufacture of sluice boxes. For further information, contact John Gutierrez, USDA Forest Service, AMEMB USDA FS, Unit 4998, APO 34037, Miami, Fl, Phone: 86 610 153/612 397, Fax: 86 623 732

Moves

As of 1 September 1994, the Mining and Environment Research Network (MERN) was relocated to the University of Bath, England. The network's new contact address is:

Dr. Alyson Warhurst, Director, MERN School of Management, University of Bath, Bath, BA2 7AY, UK. Tel: +44 0 225 826156 or Fax: +44 0 225 826157.

Corrections and Omissions

Our apologies for the following, in bulletin number 7, the author of the book review was not credited. The review was written by Dr. Richard Nötstaller.

CONTENTS

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(developing country)	$25
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