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# Small-scale Mining in Ecuador

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## Introduction

In general, a number of historic moments in the development of small metallic mining in Ecuador have been identified. The emergence of small mining took place towards the end of the 70's as a result of the bankruptcy of the *Compañía Industrial Minera Asociada – CIMA* – ( a mixed capital company, private and public) that exploited gold in the south of Ecuador, in the Portovelo-Zaruma area, after the South American Development Company – SADC O left the country around the middle of the XXth Century. The rising prices of gold and the dismemberment of the State mining administration, originated the emergence of small scale mining activities, mainly of an informal and precarious nature, developed principally by ex-workers of the above mentioned company. The illegal occupation of the concessions abandoned by CIMA, was a reply to unemployment and the crisis the mine workers were going through, which was frequently encouraged by metals speculators who financed equipment and consumables. This exploitation process, that signified a technological retreat relative to the company procedures employed by CIMA, was followed by the emergence of new installations that offered services such as grinding and beneficiation plants, due to the deterioration of CIMA's old installations and, by the generation of conflicts between miners and the State which arose due to incapacity of the State to adequately manage the regulations on mine concessions in the mining district, and that gave place to its decadence.

At the beginning of the 80's, two new mining districts emerged: Nambija in the Amazon region and Ponce Enriquez on the south western flanks of the Andes. Both were driven by the increases in the international gold price and, the agricultural crisis in the coastal plains of Ecuador provoked by the El Niño phenomenon. Their organization centered on the cooperatives that grouped informal mining societies with little technical-scientific knowledge applied to their productive activities. However, the role played by the cooperatives resulted very important in the transition towards the legalization of concessions, which has allowed for a greater margin for manoeuvring in their negotiations with the State and the mining companies.

In the case of *Ponce Enriquez*, apart from exploration work by the mining companies carried out in the 70's, the small miners began discovering gold veins and opening up small tunnels, that triggered the uncontrolled settling of miners that reported values of 150 gms per ton in different sectors at shallow depths.<sup>1</sup>

The formation of mining cooperatives came together with the incorporation of small amounts of capital originating from commercial and agricultural activities and from the development of mining activities.

With regards to *Nambija*, the artisan discovery of gold veins and pockets at shallow depths, attracted a multitude of small miners during the 80's, that converted the sector into a kind

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<sup>1</sup> Study prepared for IIED by J Fabian Sandoval with the assistance of Rolando Moya and the technical and administrative support of the Environment and Societ Foundation.

of frontier “ gold rush “. However, the drop in gold prices and the variations in gold contents, the precarious technical development (less than 40% recovery from the ore ), added to a lack of investment and underground technology, resulted in a drastic drop in production. The organization of the small miners here, was very different from that in Ponce Enriquez: it was conditioned to the spontaneous and explosive nature of the settlements, that is, they were subject to self imposed norms.

The reinforcing of small mining takes place during the decade of the 90's through the consolidation of it's productive processes, new corporate forms of organization and legal structuring.

In the mentioned decade, small mining begins to incorporate planning and technical criteria and simultaneously add modern equipment and machinery, both for drilling and blasting and for crushing, grinding, transport and recovery. These complementary investments were made by the small miners themselves and originate with planning made by professionals incorporated into the mine work and the formation processes promoted by national and international cooperation. It is worth to emphasizing that there are no public or private financing mechanisms in Ecuador for small scale mining.

Perhaps the most outstanding feature in the technological advance, is the mineral recovery through cyanidation processes that put traditional amalgamation into a second place. This fact alone, is a qualitative leap that has reflected in major benefits for the sector, both in the increase in mineral recovery, as in the decrease of environmental contamination. For example, during the 90's there are deeper mine workings and Mining Engineers and Geologists are incorporated. At the same time, capital diversification towards beneficiation can be seen in the form of cyaniding , and a tendency – by some individuals – to reinvest in activities not necessarily linked to mining, such as, agriculture, shrimp farming and tourism.

Although mining cooperatives maintained their importance during the 80's, during the decade of the 90's, they served as a base for a new form of organization: the mining associations, organization structures that start from the basic characteristics of mining societies and cooperatives, - based on relations of mutual trust through relatives, friendship, origin or previous experience – they begin to incorporate capital investment and technology.

With respect to their legal framework, a progressive tendency can be observed whereby the legislator accepts the realities of small mining, who promotes legal regulatory texts facilitating an important legal integration process for small mining. Small-scale gold production is concentrated mainly in the mining districts of, Portovelo-Zaruma, Ponce Enriquez and Nambija, in primary deposits with underground workings.

Working of **gold placers or secondary deposits** is one of the oldest and most elementary methods of gold extraction in Ecuador, where the high specific gravity of gold is used for gravity concentration, separating it from the heavy sediments. The principle actions performed are: classification of the gold bearing gravels and separation of the heavy sediments; concentration and gold separation from the heavy sediments; gold recovery by a process of amalgamation with mercury; and, distillation of the amalgam to separate the gold from the mercury.

In the processes of classification and separation, small dredges with metallic sluice boxes with rifles for gold traps have been incorporated; also, suction pumps that draw up the fine sediments from the river beds, which also provide the water for concentrating the heavy sediments.

Gold recovery is effected by amalgamation. The most rudimentary miners, perform this work manually, whilst the more developed sectors of small mining uses amalgamated sheets, amalgamation drums, vibrating screens and other equipment. Separation of gold from the mercury is done by distillation with heat, generally in the open air.

Although there are no statistics on gold production from secondary deposits, it is important to note, as an example, that in the Villa, Guanache and Siete rivers in Ponce Enriquez, a day's work in the years between 1983 and 1988, a gold washer obtained from tenths of a gram to two grams. In the 90's, this activity has notably decreased and at present, work is intermittent.<sup>2</sup>

The most relevant changes in the productive processes of metallic small mining are, in the working of **primary deposits**, particularly in the mining districts of Zaruma-Portovelo, Ponce Enriquez and Nambija, where there are underground workings.

Following the exodus of the mining companies from the mining district of Zaruma – Portovelo, the small miners obtained ore from the old workings in the mineralized structures exploited by the companies, and that were accessible without any technology. This practice is to be found in metallic workings in the entire country.

Towards the end of the 70's, mining practices of the small miners in the new settlements of Nambija and Ponce Enriquez combined manual panning with empirical exploration – that did not take into account the mineralization characteristics – by the use of manual drilling. It was not until the 90's that technical planning criteria was used for metallic mineral exploitation.

Starting in the 80's, small mining incorporated gasoline driven drills that improved drilling performance at the work faces. In the same decade, compressors and pneumatic drills began to be employed and deeper workings were executed.

At the beginning, ore **crushing** was done manually by means of a “porron”, a rocking devise weighted by stones. At the beginning of the '80s the first jaw crushers (chancadora) or Californian mills were introduced which served to increase gold production. During the middle of the same decade, the so called “chilean mills” appeared which were much more efficient, and whose use became generalized in the different small scale production centres. At a later date, ball mills were introduced which increased processing capacity. This improved ore concentration and, by using amalgamation drums (chancha), gold recovery improved even more.

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<sup>2</sup> CEPLAES (2000). Development of small scale mining in Ecuador and proposals for policies for this sector. Work document , PRODEMINDA, Quito.

Underground mine transport has improved considerably starting with the decade of the 90's with the incorporation of small, electric trains that run on rails and mine cars with rubber tyres.

Ore recovery by gravimetric concentration of the crushed or ground ore persists, with its subsequent manual amalgamation with mercury using a pan. In many cases, mercury is still burnt in the open air and in others, retorts are used to distil off the mercury. Actions have been taken to improve the methods of "burning", but with limited success. At present, only one of these is still in operation in the Ponce Enriquez mining centre.

The most important qualitative change in mineral recovery in small mining, occurred only towards the end of the 90's, when recovery by **cyanidation** significantly improved gold recovery. Two types of cyanidation processes can be observed: percolation and gravity.

## **Evolution of the Legal Status of Small Mining**

The different constitutional frameworks established in Ecuador, define basically the State policies with respect to direct dominion and, subsurface resources property.

During the period 1970 – 2001, it is possible to observe the transition that occurs in the legal concept of small mining, through different legal packages that appear in the period. The following, provides a brief legal reference of this evolution.

### ***Law for Mine Promotion (1974)***

The Law for Mine Promotion of 1994, ratifies the inalienable and imprescriptible character of State Dominion over deposits and occurrences of mineral substances, metallic and non metallic, with the exception of gravels.

The Law for Mine Promotion defines small mining as, " the activity developed by those that work mines where production does not exceed one thousand five hundred tons per month of ore" or " fifty tons daily of mineralized material"... " when this signifies the exploitation and beneficiation of placers or alluvial deposits".

The Law also establishes, that exploitation under the category of small mining, must be registered with the Registry of Small Mining (Art.41) and under the technical and administrative supervision of the Director General of Mines and Geology of the Ministry of Natural Resources and Energy.

Arts. 39 and 40 of the above law, establish that it is the duty of the State to promote and develop small mining through the Director General of Mines and geology, as one of its mandates is to encourage the formation of small mining cooperatives.

Consequently, this is a promotional policy for small mining, that creates the legal and political conditions for its development and expansion within the concepts of promotion for small and medium cooperative producers.

In fact, small mining activities differ from the general rules provided in the law, only by the size of the operation, as there are no exceptions or exemptions. This means, that their production was subject to taxation.

In addition to the general rules for mining activities and for small mining, there is a third possibility: “ the independent washers”. These could carry out their mining activities within the zones of free exploitation reserved for this activity. In order to initiate activities in the said zones, the “independent washers” do not need a permit, it is sufficient that the zone was declared of free exploitation, reserved for the independent washers ( Art. 46 of the Law and Art.16 of the Regulation).

### *The Mining Law (1985)*

A new mining law was passed in 1985, maintaining the principles of property and State control. The State exercises its functions through the Ecuadorian Institute of Mining INEMIN, a public entity, with administrative and financial autonomy, that eases the procedures for granting permits and performance of contracts and, to substantially reduce the requisites, prior reports and paperwork required by the previous law.

This law omitted all reference to small mining activities, although it maintained , as the Stated is permitted, through INEMIN, the declaration of free exploitation zones for washers and independent miners.

Small-scale mining activities which were already important, did not have a clear mechanism for their legalization and incorporation in the State processes and regulations. According to the new law, small mining continued to be a marginal activity. The new law underestimated and ignored the new reality marked by the irruption of small mining.

Towards the end of the 80's , the legalization mechanism that the small-scale miners turned to, was foriegnous to mining legislation; in effect, the creation of mining cooperatives was accepted by the Ministry of Social Welfare. However, this process maintained a condition of illegality of the small mining activities.

### *Mining Law (1991)*

In 1991, a new mining law was passed, also named Law 126, that maintains the dominion of the State over mines and deposits, however, it incorporates very clearly and categorically, the real mining rights. Thus, the mining concession has the connotation, legal status or real property and enjoys the protection and advantages of private property; despite this, the concession remains independent of the surface.

In Title X of the Special Regulations, small mining is considered a synonym of Artisanal Mining and defines it:

“... individual or family work that effects mine work as a means of sustenance and is characterized by the use of rudimentary instruments, manual devices or simple portable machines, the use of which is authorized by the General Direction of Mining”. (Art.142)

The law establishes that this activity can only be carried out in river beds and beaches and other land where no other mining rights backed by titles exist.

The Law of 1991 incorporated the concept that the State should legalize mining activities that had settled in fact, up to the date that the law was passed. Theoretically, this would avoid the environment to be affected, irrational working and the waste of mining resources; and obtain safety in operations and also to collect fiscal income in the form of patents and royalties.

It is necessary to take into account, that formal and legal forms of small mining existed and that had to adjust to the process of substitution of mining contracts for mine concessions covered by the new Mining Law (Law 126), which gave place to a group of rights and obligations that belong to them in that sense.

With regards to small scale mining activities, the 1991 Mining Law includes the situations of condominiums and mining cooperatives; it establishes that one of the objectives of mining administration, is to provide organizational assistance to communal or self administration mining activities and to artisanal mining (Art.23,lit.d).

The legal figure of condominium, attempts to group small miners together with the idea that their union will contribute to shortening the time for granting mine titles. In this manner, these small miners could present a group of applications to legalize their settlements and proceed with the necessary steps to obtain their titles.

However, there is a lack of cooperation between the small miners with regards to the presentation of technical reports, environmental studies, payment of patents and royalties, and compliance with other requisites for their titles. This led the concessionaires to the point of incurring in some of the causes for extinction of their properties. Additionally, it can be seen that there is little or no organization assistance or technical advice on the part of the Corporation for Geological-Mining- Metallurgical Investigation (CODIGEM (Art.23).

On the other hand, mining cooperatives allowed the legalization of Societies composed of small miners which have been converted into mine concessionaires, facilitating the processes of technical assistance and increased measures of environmental, social and taxation control.

With regards to the negotiations for mining areas, the legalizing of previously informal mining activities, facilitated the granting and transfer of mining rights to national and foreign individuals and legal entities that had invested in exploitation.

### ***Law for the Promotion of Investment and Citizen Participation (2000)***

This law (Law Trole II), incorporates some reforms to the Mining Law. In relation to small mining, the annulment of small or artisanal mining picture and replaced by the figure of small scale mining is significant. The reform defines “ Small Scale Mining” as,

“... that which, taking into consideration the areas of the concessions, the processing and production volume, amounts of investment, capital and technological conditions, be qualified as such in accord with the norms of the general regulation. “

On the other hand, the promotional role of the State for small mining; in effect, the reforms in the Law establish that:

“ The Ministry of Energy and Mines will promote the evolution of small scale mining to medium and large mining, through special programs for technical assistance, environmental management, mine safety and training and professional formation, with national or foreign contributions”.

In this context, the General Regulation Substituting the General Regulation of the Mining Law passed on April 17, 2001, establishes the parameters for the definition of small mining according to the size of the concession and the volume of processing and production, amount of investment, capital and technological conditions:

“ Art.48.- On small scale mining. – Small scale Mining is considered as that effected by title holders of mining concessions that fall within the following parameters:

- a) Maximum concession area: 150 mining hectares
- b) Ore extracted in the concessions: up to 100 metric tons per day
- c) Total amount of investment in the concessions, up to one million United States dollars.
- d) Technical conditions that could be improved to increase ore recovery and reduce the environmental impact.”

Of the principle reforms that assist the development of mining activities in general and small-scale mining in particular, it should be noted that: the mining concession is liable to material or accumulative division, within the limit of one hectare minimum and up to five thousand mining hectares maximum (Art.1, final clause); a duration of thirty years; and the failure to pay patents.

The divergent tendency between the State policy that attempts to encourage large-scale corporate mining in the country from 1984, and the rapid expansion of small mining activities in the decade of the 80's, determined the invasion of small miners into concessions previously granted to individual or judicial persons, with the subsequent attempts to evict them. In the face of this possibility, the growth of mining organizations such as cooperatives and federations is consolidated, as a defensive strategy of the de facto settlements and as a form of pressure for State recognition of their activities and a form for negotiating with mining companies. In fact, direct negotiation processes occurred between the small mining organizations and companies that were the owners of a concession that had been invaded.

In the decade of the 90's, these conflicts are resolved by legalizing the mining settlements. However, the growth of the sector and the absence of policies and norms , gave place to conflicts of a socio-environmental nature, aggravated by the disorderly distribution of social and productive spacing in the mining centres and the weak State control. The most significant socio-environmental conflicts, rotate around the air contamination by mercury

burning; contamination of the rivers by the free disposal of cyanide, heavy metals and metalloids; anarchical deposits of solid wastes; irrational soil utilization; conflicts with other productive activities and protected natural areas, amongst others, all worsened by the accumulated environmental impacts.

These problems have originated complaints by farmers, indigenous communities, local villages and even municipalities, of the mining activities, who have demanded the suspension of their activities and the reversion of their concessions.

## Current Importance of Small-scale Mining

### **Production, Income and Employment**

With respect to the production levels of small scale mining, the following table shows the estimated figures for the year 2000, extracted from official information and particularly from the National Direction of Mining of the Ministry of Energy and Mining of the Republic of Ecuador.

#### **Estimated Production for the Year 2000(by extraction volume) (3)**

<b>Mineral</b>	<b>Quantity</b>
Gold	5 TM*
Limestone	330 436 TM**
Construction materials	3 893 313 m <sup>3</sup>
Shales	487 006 TM**
Feldspar	70 562 TM
Kaolin	16 538 TM
Bentonita	61 TM
Sílica	41 285 TM
Marble	2 518 TM**
Gypsum	1 563 TM**
Pumis	517 274 TM**
Carbon dioxide	43 265 kg
Barytes	2 214 TM
Zeolite	1 936 TM

\* For the year 200, small scale minino produced approximately 416.6 kgs of gold per month or, 5 MT for the year.

\*\* Includes subsistence extraction

SOURCE: National Mining Directorate, Nacional Technical Unit, *Reported Nacional Mining Production 1991 – 2000*, adjustments are based on a poll of Small Miners and work meetings with the National Mining Directorate.

(3) The figures include subsistence mine production, artisan and small scale.

(4) These volumes are included in the estimated production for the year 2000 in the above table.

With regards to production not registered by small scale mining for the year 2000, the unofficial figures for the different types of minerals are as follows:

#### **Estimated Volume of Extraction, 2000(4)**

Gold	4 177 kg
Limestone	330 436 TM*
Construction materials	1 297 771 m <sup>3**</sup>
Shales	162 335 TM**

Feldspar	23 521 TM
Kaolín	5 511 TM
Bentonita	14 TM
Sílica	13 761 TM
Márble	839 TM**
Gypsum	521 TM**
Pumice	172 425 TM**
Carbon dioxide	14 422 kg
Barytes	738 TM
Zeolita	645 TM

\* 71% is subsistence production

\*\* Includes subsistence production

Source: The nacional Directorate of Minino, Nacional Technical Unit *Nacional Mine Production Reported 1991-2000*, adjusted on the basis of Polls of the Small Minerscon and work meetings with the Nacional Directorate of Mining.

In the year 2000, fiscal income came from taxation of 823 kgs of gold production declared officially. The fiscal income breaks down to: 3% royalties, 12 % added value tax, income tax.

It is estimated that 80% of income from small gold mining activities are invested in the country (includes royalties, income tax and added value tax). The balance of 20% is estimated as been used for the purchase of machinery, spare parts and consumables from international markets. As from the reforms in the Mining Law (2000), royalties were lifted for mining activity.

The following tables demonstrate the relative importance of the different socio-economic structures in the year 2000 and an estimate, for the same year, of the number of persons directly involved in small scale mining activities, according to the principle mineral:

#### **People Directly Involved in Small-scale Mining in 2000 (5)**

<b>Mining Activity</b>	<b>Men</b>	<b>Women</b>	<b>Children</b>	<b>Total</b>
Metallic	54 000	3 000	3 000	60 000
Non Metallic	27 200	3 200	1 600	32 000
Total	81 200	6 200	4 600	92 000

Includes legal and informal miners working full time all year

Source: Small Miners Poll and work meetings with the Nacional Directorate of Mines

#### **People Directly Involved in Small-scale Mining by Principal Mineral**

Mineral	No. of People
Gold	60 000
Limestone	2 000
Construction materials	21 000
Shales	2 500
Feldspar	100
Kaolin	100
Silica	250
Marble	50
Gypsum	200
Pumice	5 500
Carbon dioxide	50
Others	250
Total	92 000

Source: Small Minino poll and work meetings with the National Directorate of Mines

### **Forms of Livelihoods**

An estimate to the year 2000 of the classification of artisanal and small-scale mining, could be the following:

a) Full time, year round mining activity that is the principle means of subsistence of the home or person.

Metallic	60 000 persons
Non Metallic	32 000 persons

b) Full time mining activity, but seasonal. It is estimated that more than 1,500 persons are dedicated to part time work, sampling outcrops and washing gravels, adventurers that wish to be the pioneers in a possible mine discovery. The do not have mine concessions.

c) Part time mining activity, either all year or occasional, that provide an extra income to the home or, to satisfy a special need. For example, over the weekend, approximately 500 families from the indigenous population settle along the river borders in the Amazon region, manually wash gold gravels.

### **Systems of Organization**

With respect to the systems of organization used to carry out small-scale production and processing activities, the principle form of organization of small scale miners in Ecuador, is through concessions, as can be observed from the following table:

#### **Principle Forms of Organisation of Small-scale Mining, 2000**

Organisation	%
Concessionaires	50
Cooperatives	20
Condominiums	12
Legal associations	10
Informal associations	8

In the development of small mining in Ecuador, five principle forms of organization can be distinguished, in many cases, these are parallel or complementary.

*Concessionaires:* the State grants concessions by means of a mining title to individuals or legal entities, national or foreign according to the law.

*Cooperatives:* these commenced with the “de facto” possession of mining areas and concessions belonging to others that were not in operation, in which the small miners explored and worked in partnerships. The mining cooperatives organized themselves into regional and national federations, and towards the end of 1989 organized the I Regional Assembly of Mining Cooperatives; and in 1991, obtained legal status through the Mining Law of that year. The mining cooperatives permitted the legalization of organizations formed by small miners, which have converted into mine concession holders which made technological processes viable and increased environmental, social and taxation control. The role played by the cooperatives has been very important for the transition towards legalization of concessions, which has permitted small mining a greater margin for maneuvering in their negotiations with the State and mining companies.

*Condominiums:* the legal figure of condominium, tried to group the small miners together, with the idea that by unifying, they would accelerate the granting of concessions. In this manner, the small miners were able to jointly present their applications for legalization of their settlements and continue with the proceedings until legal title was obtained. However, it is apparent that there was an absence of cooperation between small miners for the presentation of technical reports and environmental studies, payment of patents and royalties and compliance with other obligations set down in their titles.

*Legal partnerships:* are more specific forms of organization and articulation of mining partnerships, they blend the administrative progress of the mining cooperatives, with the incorporation of investors and technicians. They played a substantial role in the process in legally formalizing small mining after the Mining Law of 1991 – through which, the State promised to legalize the situation of miners settlements that existed before May 31, 1991 – and have created conditions allowing corporate development and to obtain the inclusion of promotion and control in the State policies.

*De facto partnerships:* these constitute a very basic form of small mining organization, that groups together individual miners on the basis of mutual confidence and are entities that are based on a work force and at the same time, channel investment.

With regards to the Union organization of small scale miners, it is worth pointing out, that towards the end of 1991, The National Federation of the Austro-FEREPEMA and the Regional Federation of Miners of Ecuador, held the II Congress of Small Miners in the Amazon town of Zamora.

At a later date, the organization of Small Miners consolidated itself with the constitution of the National Federation of Miners of Ecuador – FENAMINE – and in 1996, groups together the organizations of small miners from Amazonia and the coast of the Sierra Sur.

The main objective of FENAMINE, was to legalize the operations of the small miners in the country and to encourage programs of technical development for their associates.

After FENAMINE, the National Chamber of Small Mining CAPEMINE was created in 1998 which groups together small scale miners with titles, and who have concentrated their efforts to fortifying the corporate development processes of their members.

CAPEMINE obtained their corporate charter by Ministerial Agreement No.141 from the Ministry of Energy and Mines and has been officially and legally incorporated into the General Regulations that substitutes the General Regulation of the Mining law, chapter two, literal d), Art. 85, as an integral part of the national mining activity.

### ***Involvement of Women and Children***

A first intent to try to calculate and identify the functions of women and children in small scale mining activities, is described below: (The figures includes legalized and informal miners, working full time all year round, with the exception of women washers in rivers, who are temporary).

#### Gold production

Women 3,000;

Principle activities: warehousing; wheel barrow operators; cooks; Janchadoras; and river panners.

Children 3,000

Principle activities: wheel barrow operators; loaders; and Janchadores.

#### Production of non metallics

Women 3,200

Principle activities: manual extraction; manual crushing; loading; and bagging

Children 1,600

Principle activities: mine extraction; crushing; and bagging.

### ***Indirect Economic Benefits***

The identification of indirect economic benefits or multiplying effects of small-scale mining in Ecuador, can be resumed in the following points:

1. It is estimated that some 25,000 persons are involved directly in the following activities:
  - a) Sale of foodstuffs, provisions, canned goods, cleaning products, catering, dormitories, bathroom rental, clothes washing, storage etc.
  - b) Construction; homes, storage etc.
  - c) Sale of tools, equipment etc.
  - d) Transport and fuel
  - e) Construction of houses, civil works for production, beneficiation etc.

- f) Sale of mining consumables
- g) Workshops, foundry, mechanical, electrical etc.

2. Multiplier effects

- a) Birth of townships such as, Pangui Conguimme, la Herradura in the El Condor mountain range, Bella Vista, Puerto Minero in the province of Zamora and the expansion of San Gerardo, Ponce Enriquez , Gena, Naranjillas, amongst others in the provinces of Azuay and El Oro.
- b) Construction of penetration roads and tracks which can be built by the miners themselves, provincial councils and/or municipal councils.
- c) Activation of motorized transport.

## Environmental Impacts

### ***Metallic Mining***

According to the environmental survey carried out in several gold mining districts in the country, characterized by the intensity of small mine workings during 1996 and 1998, one concludes:<sup>3</sup>

“ Gold mining in southern Ecuador has caused considerable environmental impacts, the most severe being in the areas of Portovelo-Zaruma and Ponce Enriquez. The principle contaminants are cyanide, heavy metals and mercury. The most significant sources of these contaminants, are the tailings discharged directly or indirectly into the rivers due to inadequate disposal systems. The discharge of these contaminants has caused the extinction of every form of higher life in certain sections of the rivers; additionally, in several places the water is no longer potable and cannot be used for irrigation or aquatic breeding.”

The main environmental impacts caused by small scale mining in Ecuador, can be summarized in the following table:<sup>4</sup>

		<b>Area/basin of potential conflict</b>	<b>Grade of Impact</b>
Soil use	Loss of agricultural land	All the basins	Not significant
	Loss of land for homes	Portovelo-Zaruma	Significant
Biota	Loss of biodiversity	Río Puyango Río Siete Río Gala / río Chico	Severe
	Incorporation of heavy metals by organisms.		Significant

<sup>3</sup> Ministry of Energy and Mines Ecuador (1999) Environmental Monitoring in mining areas in southern Ecuador. 1996-1998, PRODEMICA, Quito

<sup>4</sup> Ibid

	Accumulation of Hg by organisms		Significant
Water resources	Loss of potable and irrigation water	Río Siete	Severe
	Loss of water for acuatic cultivation		Severe
Other economic activities	Impact on the shrimp industry		No impact
	Impact on the banana industry		
Human health	Subject to investigation and special reports		

### **Non Metallic Mining**

There are few studies and evaluations on environmental effects in non metallic mining. However, it should be emphasized that the majority of operations (small scale in volume) related to extraction of building materials, present grave technical deficiencies that have caused caving of quarries and the intervention of the authorities to close the operations. In this regard it is possible to prioritize at least three aspects:

1. Risk of quarry cavings due to inappropriate working slopes;
2. Particle emissions to the atmosphere; and
3. Significant landscape changes.

### **Present Practices**

With respect to present mining, processing and environmental control practice and the latest changes, in gold mining the most used method is by horizontal tunneling and stoping upwards selectively extracting the ore which yields low ore recovery; the horizontal advance is made by drilling and subsequent blasting

Ore transport in the more advanced mines is by means of ore cars on rails with electric or battery driven locomotion, whilst in the less developed mines, extraction is by means of wheel barrows.

Ore beneficiation is carried out by crushing, grinding with Chilean mill or ball mills, followed by gravity concentration and subsequent mercury amalgamation. In many cases, cyaniding processes are employed.

Some of the significant changes in small scale gold mining activities over the last 10 years, were due to the incorporation of technical personnel in the production processes and the technical assistance progammes, both national and international (referred to further on) and, the organizational development of the small miners. The principle changes are summarized as follows:

- Application of mining methods that offered safety
- Incorporation of blasting techniques
- Incorporation of improved mine transport systems

- Partial incorporation of safety equipment
- Partial incorporation of retorts for mercury distillation
- Consciousness of environmental problems and the necessity in many cases to improve existing technology and incorporate clean technology.
- Environmental control, as soon as 90% of small mining has been incorporated into the Mining Legislation, it will accept the challenge and be obliged to comply with environmental norms.

It is estimated that these significant changes could have benefited approximately 10,000 small miners.

The *non metallic* mining activity on a national scale, is principally one of subsistence and 82% artisanal with only 18% of mechanized quarries; however, in both cases, close to 97% operate without any technical planning.

The production system is mainly open pit , using manual methods, no technical planning and with steep work faces and unstable slopes. In a few cases, explosives are used, although in the majority of cases this is done without professional guidance.

It is estimated that 99% of the quarries producing different materials, do not comply with the standards of the Ecuadorian Institute of Standards – INEN.

Production of pumice stone is a subsistence activity carried out by open pit methods by family groups; production methods have improved with the use of equipment and machinery. All activities, tend to incorporate into a formal commercialization process.

Limestone production is also a subsistence activity effected by underground and open pit methods; there is no planning or technology, it is directed principally to the production of lime for construction

Shale production is also a subsistence activity, it's use is principally for the fabrication of adobes used in the construction of one floor native dwellings. The adobes are roasted in a primitive fashion using brushwood from the surrounding forest for fuel, and used for construction.

## **Support Activities**

During the last 10 years, support activities for small mining have come principally from International Cooperation and State institutions. In fact, all of the reduced assistance for small scale mining, has been in the form of technical assistance and no programs for financial or credit support, neither from the State, the private sector, national or international.

## **International Cooperation COSUDE Project**

In 1993, the Swiss and Ecuadorian governments entered into an agreement for a project for the “ Minimization of mercury emissions by Small Gold Mines in southern Ecuador”. The financing (us\$550,000) source was the Swiss Government Technical Cooperation (COTESU). The project had two phases, 1993-1999 and 1999 to the present.

### **Phase I**

According to the information published by the project, the principle objective in the first Phase I, 1993-1995, was, “the minimization of mercury emissions produced by small gold mining in Portovel o/ Zaruma, by the introduction of mineral processing techniques that do not contaminate the environment and, contribute to an improved yield and economic benefit for mining.”<sup>5</sup>

From 1995 (Phase II), after two years working with small mining and based on an understanding of the mining-environmental problem of the Portovel/Zaruma area, the principle objective of the project was redefined and which today hopes to reduce the environmental impact caused by small gold mining in it’s extraction and beneficiation stages in Portovel o/ Zaruma.<sup>6</sup>

“ In order to achieve this principle objective, the program proposes to reach the following objectives:

“ Increase environmental awareness at all levels; miners, the affected population, State and private organizations and political levels with the power of decision;

“ Introduction of technology and techniques to improve production and beneficiation, that do not have negative repercussions on the environment and the health of the population.

“ Education and awareness of the small miner and the population in general regarding environmental matters.

“ Training the local and regional metal-mechanical industries to produce equipment for small mining, that are economical and fit the mining conditions without risking the environment of the zone.

“ Reinforce the local institutions so that, in the future, they can continue with these measures in favor of the environment of the work area.

“ Provide technical advise to the miners an mining partnerships on solutions for their geological-mining and environmental problems.”<sup>7</sup>

The principle activities of the project were:<sup>8</sup>

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<sup>5</sup>Hrushna F., et al (1995) The mining project without contamination at Zaruma/Portovelo, El Oro-Ecuador, Minutes of the II Ecuadorian National Congress for the Environment, Quito.

<sup>6</sup> Ibid

<sup>7</sup> Ibid

- *The Eco Plan + Environmental impact studies and plans for collective management*

In the form of a pilot plan, the collective environmental impact study was prepared (ECO-Calera), for 58 beneficiation plants in the most contaminated area of the region, which are the banks of the river Calera. In order to carry out the individual environmental management plans, an agreement was signed with the Association of Proprietors of Gold Beneficiation Plants - APROPLASMIN. Complementary to this, in 1994 the Ministry of Energy and Mines issued the Ministerial Agreement No. 217, permitting collective studies of the environmental impact to be carried out and collective plans for environmental management; additionally, the municipalities of Atahualpa, Piñas, Portovelo and Zaruma, signed an agreement for the creation of the Environmental Management Commission – COGEAM.

- *Environmental diagnostic for mercury*

The project carried out an environmental diagnosis with regards to mercury in air, water and sediments in the study area in 1993. For this diagnosis, samples were taken of water (rivers), sediments (rivers) and air (in the places where amalgam was burnt and there were amalgamation plants), the results of this diagnosis were published.

- *Technical assistance program for small-scale miners*

The technical assistance program was focused on the fields of geology, mining, ore beneficiation and the implementing of environmental ideas. To do this, agreements were subscribed with mining groups to jointly implement pilot plants with adequate beneficiation technology; provide support for the solution of geological-structural, cyaniding, gravity recovery and mercury recovery problems amongst others. One of the results was to in some measure, overcome the lack of confidence of the miners in technical people.

As part of the technical assistance, it is worth mentioning the Project's participation in the conflict between, The Association of Independent Miners San Antonio de Guizhaguíña (Trencillas) and, the community and authorities of Portovello, over the use of the water of the river Luis. The water used by the potable water plant of Portovello taken from lower river Luis, was contaminated by the miners working the upper river.

After a joint agreement, the Project gave technical advise to the miners for the initiation of organized mining activities without negative effects on the river Luis, through a commitment by the Association to comply with the plan for environmental management prepared by the Project, and the legalization of the mine concession Trencillas .

- *Design, production and marketing of the mercury recovery retort.*

A model was developed that fitted the requirements of the miners in the zone. A few examples were produced locally and used for demonstration purposes, which obtained

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<sup>8</sup> Ibid.; CENDA/COSUDE/Projekt-Consult (1999), Proyecto Ecuador: Minería sin Contaminación, Informe final Fase II, Marzo, Loja

mercury recoveries of up to 98-99%. At a later date, retorts were produced, however, due to the lack of diffusion and marketing of the product, generalized employment of the mercury recuperator was not obtained.

- *Confection of detailed mapping*

Together with the Private Technical University of Loja, digital mapping of the Portovelo-Zaruma zone was carried out at a scale of 1: 10,000 and work maps were edited showing information on environmental monitoring results, mine installations and mines.

- *Introduction of new technology*

The viability of technologies such as the Knelson concentrator, the countercurrent hydro classifier and filters for nitrous gasses were studied, with interesting results but did not prove to be practical.

- *Occupational health*

Two hundred persons were investigated in the Portovelo-Zaruma region; the clinical examinations showed that, almost a half of the people directly involved in mining, showed signs of mercury intoxication. The mercury impact on the rest of the population groups was not so high, this means that the initial problem in the region, is one of occupational health.

- *Socio-economic study*

The preparation of the socio-economic study with a focus on class, gave access to knowledge of the social and economic problems derived from gold workings in the region, as also cultural and organization problems of the population; the preparation of proposals for intervention and strategies for interaction between the Project and its beneficiaries.

- *Program for awareness and environmental education*

With the cooperation of the Private Technical University of Loja, a program for awareness and environmental education was introduced for Portovelo and Zaruma. This included a program for the entire community of the region and the inclusion of a post graduate seminar direct towards graduates in educational sciences and a course regarding the theme of the agreement. The *Environmental Booklet* was produced for use as base material.

- *Diffusion and communication*

The Mining Bulletin was published from September 1993 and was distributed locally, regionally and internationally, with 2,500 numbers per month. It gave information on the principle activities of the Project and the CENDA Foundation and what was going on in mining in Ecuador.

- *The children's dining hall*

The children's dining hall program presented by the CENDA Foundation to COTESU, was approved in 1993, and started attending poor children in two townships with miners and homes of scarce economic resources. Seventy children are being fed with this program that is an important assistance, with the intention that it will be continued in the future by the community with its own resources as a sustainable program

- *Goldsmithing workshop and course*

An agreement was subscribed with the National Center for Small Industry and Artisanal – CENAPIA – to install a Goldsmithing workshop in Zaruma and provide a course in Goldsmithing. This produced 11 graduates who now produce silver jewelry that is sold in Zaruma.

- *Interinstitutional cooperation*

Through the Project's technical counsel – composed of State organizations, NGO's, Universities, Chambers of Mines, and local organizations - the Project seeks inter-institutional cooperation, interchange of experience and knowledge of the mining area amongst others.

## **Phase 2**

Starting with first quarter of the year 2000 and within the binational (Ecuador-Peru) context, COSUDE continues with it's technical assistance for small gold mining in southern Ecuador through it's project, *Implementation of environmental measures in artisanal mineral beneficiation plants located along the river Calera/Salado*. Participants in the Project are; the State through it's Ministry of Energy and Mines (UAM-MEM), the PRODEMINCA project of the same Ministry with World Bank financing and the private company SERVIGEMAB Ltd.

The summary of the objectives is as follows:

- Preparation of 6 complete environmental management plans for beneficiation plants.
- Execution of work emergent from environmental prevention and control measures with resources of the plant owners along the river Calera.
- Design of two alternative collective cyanidation tailings dams.
- Training and technical assistance for the construction, operation and maintenance of the corresponding installations.

According to the progress report of the first working quarter, information has been gathered for the data base by means of a survey, combined with measurements for a total of 46 ore beneficiation plants in la Calera. After analyzing the information and defining selection and priority criteria, the number of installations involved in the Project was reduced to 24: 6 for complete management plans and 18 for the preparation of plans for emergent measures. It is understood that the first have economic capacity to individually implement the proposed management plans.

The commitment by the plant owners to invest in contamination control and prevention measures, did not remain clear; neither is there a definition of the role of AUAM-MEM and PRODEMINCA in the Project.

- *PRODEMINCA Project*

Between 1995 and 2000, the Project for Technical Assistance for Mine Development and Environmental Control – PRODEMINCA (World Bank loan BIRF 3655-EC for us\$15 million), carried out a sustained support program for small scale gold mining, which can be summarized in the following aspects.<sup>9</sup>

- *Gold recovery in concentration processes*

Between 1995 and 1998, diverse types of metallurgical investigations were carried out with the technical assistance of Swedish Environmental Systems – SES -, that have contributed to a better understanding of the different types of gold mineralization that exist and are being worked in Ecuador and also, their treatment. Several plants have accepted and introduced improvements and, global gold recovery is now between 80 and 90%. Small modern cyaniding plants for gravity concentrates are operating in all the mining districts (with the exception of Nambija).

SES has recommended:

1. Investigate oxidation methods that make refractory gold accessible to leaching solutions.
2. Promote central integrated processing plants instead of small plants, in two phases (mills/slucices and cyaniding plants)
3. Replace amalgamation by cyaniding for gravity concentrates.

- *Use of alternative concentrating methods to substitute amalgamation*

The investigation and promotion of alternatives to replace mercury, has resulted in the use of small-scale cyanide plants, demonstrating that it is possible to eliminate the use of mercury in small-scale mining, which brings with it an improvement in environmental conditions, health and economic advantages.

In this respect, as in the previous case, the main obstacle encountered to obtain the improvements indicated, are personal interests of individuals who resist investing to integrate with larger production units.

- *Technical underground production*

By means of courses and meetings for the interchange of experience, an improvement was obtained in the level of mechanization for drilling and blasting, ore transport, ventilation, timbering and safety, efficiency and profitability of underground operations.

The main obstacle, is the small scale of underground gold operations that make it difficult to make the necessary investments required.

- *Knowledge of ore reserves in the principle mining areas*

The initiation of some geological investigation was achieved with some of the small scale mining partnerships and companies, permitting them to know their ore reserves and mine potential in order to plan their investments.

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<sup>9</sup> Ministry of Energy and Mines Ecuador (1999) Swedish Technical Assistance: Final report PRODEMINCA. Quito.

The small scale of gold operations in Ecuador and the short term attitude with regards to these operations, make necessary investment in exploration and investigation to know their reserves, difficult.

- *Improvement of hygiene and work safety conditions*

A massive campaign for training and awareness of health and safety for miners was effected and also investigation on occupational health. Some better organized small scale companies and partnerships, have changed equipment and operating methods to improve work conditions. However, the lack of organization, economic means and interest in changing operating methods and physical conditions, are still an important obstacle.

- *Support for organized mining associations*

Despite the unstable economic and political atmosphere and the reduced international investments, the small scale mining companies and partnerships, have improved their forms of organization and operation with a tendency towards a more corporate style. In fact, some cooperatives and partnerships, under the direction of young and dynamic mining executives, have converted into mining corporations, modernized and mechanized their operations and improved environmental management; this has led to a measure of profitability despite the drop in gold prices.

## **Government Projects**

### **CODIGEM**

With the support of Corporation for Geologic, Mining and Metallurgical Investigation CODIGEM, a technical institution annexed to the Ministry of Energy and Mines and, with the auspices of the National Chamber of Small Mining – CAPEMIN - , since 1995 there have been training courses held within the framework of the Portovelo Mining Fairs.

### **INEMIN**

The Ecuadorian Institute of Mining –INEMIN- a technical organism annexed to the Ministry of Energy and Mines, has made efforts in the process of modernizing small mining. For example, under the initiative of the Technical Undersecretary of the Ministry of Natural and Energy Resources, in 1995, INEMIN designed a promotional pilot plan for the use of retorts for amalgam in Nambija. It's application was only partial and the results were not those originally expected due to the lack of interest on the part of the miner to change his production routine.

### **DINAGE**

The reforms in the Mining Law and the General Regulations Substituting the General Regulations of the Mining Law issued in April 2001, state in it's Art.49 that:

“ The Ministry of Energy and Mines will encourage the evolution of small scale mining towards becoming medium and large scale mining, through special programs of technical

assistance. For this effect, title holders of small scale mining concessions, will present , during the month of December each year, an application which will contain the specific requirements for assistance for the following calendar year.”

The regulation also indicates the limitations of this technical assistance, and emphasizes compliance with the obligations of the small miners as concession holders.

“ Technical assistance can only be applied to specific short term aspects and, under no concept be destined to reports that, as established by the Mining Law and it’s Regulations, must be presented by the title holders of mining rights.”

With regards to the operation of technical assistance, the same regulations states:

“ For each case, the Ministry of Energy and Mines will determine the procedures and will subscribe the necessary agreements for granting the technical assistance refered to.”

At present, the National Direction of geology – DINAGE - , together with CAPEMINE, have signed an agreement for technical assistance and institutional cooperation and the search of economic resources.

### ***Private Projects***

There have been a series of support initiatives for small-scale mining on the part of civil organizations, professionals and the academy amongst others:

#### ***The Association of Mining Engineers***

In the year 2000, a course was given on underground mining addressed to the National Chamber of Small Mining of Ecuador, and other training activities have been planned. The lack of financing is one of the problems being faced.

#### ***OIKOS***

During the year 2000, an agreement was signed with the National Chamber of Small Mining, to carry out mining environmental audits, which are being executed at this time.

#### ***Environment and society***

In 2001, an agreement for reciprocal assistance and mutual cooperation with the National Chamber of Small Mining, for the joint promotion of environmental and social themes which is also being executed.

#### ***ILDIS***

The Latin American Institute for Social Investigation – ILDIS – is incorporating in it’s planning for 2002, training activities on socio-environmental mining themes.

# Interactions between Small- and Large-scale Mining Companies

## **Negatives**

### *MINPALCA and Miners from Ponce Enriquez and Gabi (1997)*

Negotiations in these mining areas between the mining company and small scale mining, were carried out without the participation of government authorities, without reaching an agreement, due to the lack of negotiating capacity of those involved.

### *GRIVIP ANDOS and Nambija Miners (2000)*

Due to erroneous technical and economic criteria, the evaluation of past mine workings by small miners, was over-dimensioned. As a consequence, the negotiation effected was based on unreal facts, which led to conflictive relations between the company and the small miners, to such a point, that in September 2001 the government through the Ministry of Energy and Mines and the Armed Forces, had to intervene in the area of mine concessions to avoid worsening of the problem.

## **Positives**

### *ODIN and Miners from San Gerardo and Pinglio (1994)*

The company developed a policy to fit relations with the community through the execution of infrastructure work and the rehabilitation of the gold producing area. Additionally, the company permitted the artisanal miners to wash the gold gravels of the shores of the river Gala, despite the fact that these were inside their concession. Once the company had concluded its production and investigation activities, small scale mining activities were permitted, perhaps because the size and characteristics of the primary deposit were not sufficiently attractive for the company. At present, small miners maintain concessions in this area.

### *IAMGOLD and miners from Zaruma-Portovelo (2000)*

The company has negotiated on firm bases with the small miners – without State intervention – and has arrived at agreements for development of mutual benefit, which at present have improved the perspectives of the deposit.

### *PROMINEC and Miners from Ponce Enriquez: exploration agreements.*

The company maintains solid relations with the small miners – without the participation of mining authorities – through exploration agreements, which will permit it to have increased technical knowledge of the deposits and increase their potential.

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