Decommissioning of mines, sustainable development policies and environmental solutions: Brazil and Canada

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RESUMEN: Decomisión fue un término usado con anterioridad en las instalaciones nucleares, y que puede ser utilizado en la actualidad en lo concerniente a la actividad minera, el manejo de los residuales, efluentes, escombros y colas, así como en el acondicionamiento final del área. En muchos países se han analizado nuevas prácticas medioambientales dirigidas al sector y las tecnologías mineras, con el fin de lograr un compromiso entre las actuales y futuras generaciones.

Las discusiones sobre el desarrollo sostenido para el sector minero están realmente avanzadas en Canadá, como resultado de la alianza entre los organismos gubernamentales y las compañías mineras. Las nuevas políticas y tecnologías referidas a la decomisión han ocupado un lugar muy importante. Algunos problemas medioambientales han sido considerados más profundamente que otros, tal como el drenaje ácido de las minas, lo que significa un impacto perdurable. Brasil es también un país rico en recursos minerales, donde la actividad minera ocupa un lugar relevante. La política medioambiental brasileña aún no contempla con suficiente profundidad la etapa de decomisión y la generación de drenaje ácido de las minas. Desde el inicio de la actividad minera, ha sido muy importante considerar las acciones llevadas a cabo en la decomisión de las minas, dirigidas a minimizar los impactos medioambientales y alcanzar el nivel mínimo de emisión. El presente artículo muestra una reflexión sobre las iniciativas canadiense y brasileña y su contribución a esta discusión.

Palabras claves: Decomisión de minas, actividad minera, política medioambiental.

ABSTRACT: Decommissioning was a term formerly used to nuclear facilities, that can be used nowadays concerning the end of mining activity, the management of residues, effluents, waste rock and tailings, and the final conditions of the area taken into account its next use. Aiming at the compromise between present generation and future ones, new environmental policies for the mineral sector as well as for mining technologies have been discussed for many countries.

Discussions about sustainable development for the mining sector are really advanced in Canada, as a result of the alliance between governmental agencies and mining companies. New policies and technologies, at the stage of decommissioning, have been playing a very important role. Some environmental problems have been considered more serious than others, such as acid mine drainage which represents an impact for a longtime. Brazil is also a rich country in mineral resources where the mining activity plays a very important role. The national environmental policy does not contemplate yet, very deeply, this stage of decommissioning of mines and the acid mine drainage generation. Since the beginning of the mining activity, it is important to consider the actions taken until the decommissioning, aiming at minimize the environmental impacts and reach the minimum level of emission. This article presents a reflection about Canadian and Brazilian initiatives and their contribution to this discussion.

Keywords: Decommissioning, mining activity, environmental policy.

INTRODUCTION

Decommissioning of mines is a very important stage of the mining activity and it has to be considered as a particular stage. Previously, the term *decommissioning* was just used for the nuclear facilities and installations. Considering all the controversies, this concept, nowadays, is being used by some parts of Brazilian mineral sector to characterize the last stage of mining activity, including the closure, the rehabilitation of the site and its monitoring.

The new use of this concept leads us to the discussion of how many and which are all the stages of the mining activity; which are the technologies adopted during all these stages, theirs costs and the feasibility of the undertaking project. Although, in some developed countries, the discussion of the applicability of this concept to all mining projects is very advanced and, in some cases, as in Canada, the term *rehabilitation* has been adopted instead of *decommissioning*.

Several technological solutions employed worldwide in mining reflect a lack of concern with the environmental impacts due to this activity during all its stages. Up to now, the main goal of new technologies in the mining sector has been to make more money, by exploring mineral resources deposits as much as possible. Otherwise, considering all the stages of the mining activity, the mining companies have a global idea of their environmental problems just at the final stage, known as *decommissioning of mines*. The environmental technologies in this sector are developed and applied only in a few countries.

Naturally, Canada is really more developed than Brazil in mining technologies, in elaborating a few environmental solutions and policies and practicing some undertaking strategies, allowing broad public participation in decision-making as a feedback provider in the early stage of these mining projects. Therefore, in both countries, it will be necessary to climb a lot of steps in all the economic sectors, including mineral and metals.

The objective of this paper is to discuss how Brazil's and Canada's mineral sectors have considered the stage of decommissioning of mines. Aiming at comparing practical issues and the technological solutions adopted during the decommissioning of mines, in both those countries, to minimize or solve environmental impacts due to the mining activities, some cases of acid mine drainage generation have been selected to be presented here.

BRAZIL

Decommissioning of mines and sustainable development policies

Brazil's legislation on environment until the 80's was sporadic and basically directed towards preserving the so-called *renewable natural resources*, such as water, soil and air, specifically at the interface of protecting the worker at his place of work (Barreto & Villas Boas, 1998).

A new concept of environment emerged in Brazil in the 80's. It is possible to recognize a lot of initiatives towards the elaboration and improvement of environmental policies and technologies dated from that period, as the National Environmental Policy (Law 6.938/81), the creation of Ecological Areas and Environmental Protection Areas (Law 6.902/84), the CONAMA Resolution (1986), the establishment of the new Constitution (Brasil, 1988) and the Earth Summit in Rio de Janeiro (1992).

The CONAMA Resolution (1986) established a definition to environmental impacts and the obligation of doing some environmental reports (EIA, RIMA, PRAD, EPIA, etc.) in a lot of sectors and activities, like Canada and the United States had established before.

The Brazilian Constitution was reformulated in 1988, with the introduction of a chapter about environment - Chapter V (Brasil, 1988). This Constitution has an article (Art. 225, § 2) which ordered the recuperation of sites degraded by mining activity, but at the same time, recognizes that mining activity can degrade the environment (Brasil, 1988).

The environmental impacts that result from this activity are not very well detailed, neither the environment impacted (air, water, etc.). There is no specific concern in Brazilian laws about all kinds of environmental impacts (social, economical, physical and biological impacts) resulting from all the stages of the mining activity, and neither about the decommissioning of mines. More specifically, if it is thought about a particular problem, as the acid mine drainage, there is no consideration about that in Brazilian environmental policies and laws.

Considering more specifically, the mineral sector, the Brazilian Mining Code, dated from 1967, was directed to mining exploitation and to the prospectors' rights. This code was reformed twice: at first time in 1986 (International Bureau of Fiscal Documentation, 1995) and lastly in 1996 (Barbosa and Manes, 1997).

In 1996, the Law 9.314/96 altered the Mining Code, contributing to the new investments in the Brazilian mining sector (Barbosa and Santos, 1997). In spite of all discussions about environmental impacts since the beginning of the 80's and considering a dossier elaborated by Pro-Minério (São Paulo, 1987) aiming at the improvement of the legislation regarding mining and environment, it is incredible that the new Mining Code does not have any concerns about this subject.

Mining site recuperation, according to the CONAMA Resolution (Brasil, 1986) 1 to the Brazilian Constitution (Brasil, 1988) and to the Brazilian Environmental Laws, means the site restoration without containing any specification of what must be restored and nothing about how to do the recuperation. In this way, in a lot of cases, the visual impact was looked at as the worst impact of the activity and just revegetation was accepted by the governmental supervisors as one restoration of mining sites.

The mining activity was considered, by the mining companies and the Brazilian government, as having an environmental impact only until the end of the mining production, because this is this last stage of the mining activity taken into account by Brazilians from mineral sector. Most of the time, the following concern was never included for: how long there will be a contamination on the site; what will happen with the site after that; which kind of activity will be installed, and which conditions the next user will find in the site to install the new structure.

The concept of polluter-payer exists in Brazilian policies, but there are not enough tools to make this applied all the time. Brazil also uses technical parameters that determine the level of contamination by chemical agents, in different sources of pollution, although they do not cover all the toxic substances (Barreto & Villas Boas, 1998). When they were considered, they could be found in environmental and labor legislation, in specific rules.

Some parameters used in Brazil are dictated by international bodies, such as the EPA (*Environmental Protection Agency*), and the ACGIH (American Conference of Governmental and Industrial Hygienists). On that way, sometimes these parameters and standards are not appropriated to Brazilian conditions.

After the Constitution, the elaboration of a dossier with some environmental directives to the mining sector was another important step taken by the Brazilian government (Brasil, 1997). This is the first dossier where it is possible to hint a preoccupation of the Brazilian government about the stage of decommissioning of mines. In

Brazil, it is very important to consider the different scales and kinds of mining activities: some illegal and informal mining activities, "garimpos" and other artesanal mining operations, sand and clay exploitation, small, medium and large mining companies. It is very important also to consider the cultural differences of some regions and states, the conditions to implement and control the policies and technical solutions of each region and mining undertaking, the human and technical resources of each region, governmental organizations and mining companies.

The Brazilian government is beginning to discuss on environmental concerns in the mining sector, doing a lot of considerations before arriving at the elaboration of environmental policies: 1) Old mining sites contamination; 2) Small scale and artesanal mining operation; 3) Illegal and informal mining activities; 4) Lack of human, financial and technological resources; 5) Antagonism between "conservationists" and "developers", and 6) Lack of scientific knowledge (Borges, 1998).

Nowadays, considering the political, economical and technical conditions, a short-term strategy is being established with the following concerns (Borges, 1998):

- Training human resources and development of technological partnerships through international cooperation programs.
- Establish a partnership between government, private sector and other social agents, in order to promote the sustainable development objectives.
- Stimulate regulation process and standards' definition for the environmental protection and monitoring.
- Invest in decontamination and recuperation of critical areas.

Issued February 1998, the new environmental law of environmental crimes (Brasil, 1988) establishes that the research, extraction or exploitation of mineral resources, without the licenses required by law, will be punished in two ways: be arrested and get a fine. The same punishment is due to whom does not recuperate the mining site as required by law. Therefore, this law is very new for evaluation, but it seems very general, without presenting more details about the punishments and about its tools of control and fiscalization.

Environmental solutions, results and monitoring

The preoccupation with the decommissioning of mines is very new in Brazil. At first, the Brazilian mining sector had a preoccupation only until the end of production. Then, when the site was not abandoned, the mining companies started to take some decisions regarding the visual recuperation of the area. Nowadays, some companies are beginning to consider the decommissioning of the mines as the final stage of the mining activity and to be worried about environmental issues at this stage.

We are trying to illustrate below some examples of what is going on in some Brazilian mines in the Poços de Caldas region, state of Minas Gerãis. This region is very rich in mineral resources, having the presence of some highly regarded mining companies.

The uranium mine of INB (Nuclear Industry of Brazil) located at the CIPC (Complexo Minero-Industrial de Poços de Caldas), in Poços de Caldas, is in the stage of decommissioning. There is a lot of waste rock deposits, a tailings dam and the open pit mine, with the problem of acid mine drainage generation. The biggest environmental problem is that the waste rock is generating acid mine drainage which is emerging in a lot of points and they do not have a good characterization of the waste rock, neither a control of where they could have more or less oxidation. They have three major areas of concern:

1. Waste rock 4 (of which higher slope has 90 m).
2. Waste rock 8, spreaded in a big area, which encompasses many sites with possibility of infiltration and contact with natural lakes and basins.
3. Open pit mine, where more or less 900.000 m^3/year of water are pumped from the Nestor Figueiredo Dam, which is located on the base of the Waste rock 4.

In CIPC there is a plant of water treatment, with addition of lime and barium chloride. The INB is trying to minimize this environmental impact of acid mine drainage generation in taking some solutions as pumping and doing the treatment of the acid water, covering and putting some plants over the waste rock deposits. Although, as there is no characterization of the waste rock deposits, sometimes these solutions are not appropriate.

Also, there were a lot of proposals from some companies and institutions to characterize the waste rock deposits, aiming at knowing all the major emergencies and infiltration of water, which are contributing to the acid mine drainage generation.

For example, an Australian Research Center, named ANSTO, presented recently a proposal to this stage of decommissioning: to obtain the hydrological balance, with the installation of lysimeters at Waste rock 4. Later, they were intending to do the characterization of all the area.

Unfortunately, the Brazilian company (INB) is in these last years studying a lot of proposals, without making a decision aiming at a better understanding of its environmental problem before implementing the best technical solution. For instance, this company is only extending the acid mine drainage generation for some years.

These region of Poços de Caldas is specially very rich in bauxite (aluminum), explored by some big companies, one of them named CBA (Brazilian Company of Aluminum). This company has taken a lot of interesting measures to solve the environmental impact in its mining sites. In the case of this kind of mine, there is no acid mine drainage generation, but there is a big problem of erosion. This private company has a lot of areas restored near the city of Poços de Caldas, where it is possible to observe some channels to divert the water and some small pits, filled with chemical fertilizer and lime, avoiding the erosion process. Afterwards, some plants are being putted over the mining site. This company has a nursery with

different kinds of plants, aiming at doing some tests on top of the mining sites.

CANADA

Decommissioning of mines and sustainable development policies

In Canada the most important initiative about the sustainable development policy which is considered for all the sectors of the economy, is the elaboration of a policy specifically aimed at minerals and metals in the mining sector.

Aiming at the implementation of this policy in the mining sector, the Canadian government has improved the partnerships between federal government, provincial governments, mining industry and other relevant institutions in this sector. The government became able to mobilize at the same time different groups and associations and a very important social strata, yearning for the making of more representative decisions. In that way, there are a lot of associations and governmental organisms created for the evaluation and management of contamination and environmental hazards, resulting from the mineral exploitation, tailings and waste rock disposal.

However, the government had established a compromise of supporting the principle of the utilization of minerals and metals, recognizing the necessity of changing and improving the environmental policies and laws.

The Canadian Law of Mining has some environmental concerns and considers all toxic substances and all kinds of contamination of the water resources regarding the mining activity. In the Canadian Law there is also a lot of links between all the policies; for example, looking at the Water Laws and Regulations, there is always some concern about mining activity and its impacts; looking at the Mining Laws and Regulations, there is a lot of concern about water, air and soil conditions, contamination, prevention and monitoring of all kinds of impacts.

There are also some particular laws which could be applied to the mining sector, to the management of ground water, tailings and waste rock disposal, and acid mine drainage generation.

The concept of polluter-payer is really available in Canada. The mining company has to deposit in a bank, since the beginning of the mining activity, enough money to the environmental recuperation of the area. That amount will be used only at the decommissioning. This norm is very interesting: if the company does not have enough money to grant that the recuperation of the area will be done in the end of the activity, it will not be authorized to explore the mineral resource.

An important progress in the mining sector, done by the Canadian government, has been the establishment of the mining activity as an economical activity with some principal stages, different from old conceptions.

It considered as mining activity since the beginning of the research on the mining site, including the exploration, the prospecting, the beginning of activities at the site, the milling, the refining, the production, the closure, the decommissioning of the mine and the subsequent monitoring and maintenance of the area.

Table 1 presents a summary of these stages of the mining activity in Canada (Barreto, 1997).

TABLE 1. Stages of the mining acttivity by the Canadian government

Exploration	Development	Production	Suspension	Closure	After closure
Research of data.	Structures.	Exploration.		Site rehabilitation.	Monitoring and
Preliminary	Development	Evaluation of mineral		Monitoring.	maintenance in the
exploration.	of the mine.	reserve.		Closure.	future.
Prospecting.	Planning.	Technical and economical			
Evaluation of	Building.	modifications.			
geological reserves.	Project.	Tailings and waste			
		rock disposal.			
		Environmental			
		improvements.			
		Annual reports.			
		Promotional events.			

It is very important to observe that the Canadian government is considering as mining activity, not only the closure and the rehabilitation of the area, but also the maintenance of the area in the future. Considering a sum of all these stages, Table 2 presents the key activities and potential environmental impacts of each phase of mining, according to the Canadian vision (Barreto, 1997).

Considering Table 2, it is clear that in Canada there are some discussions about environmental problems and solutions during all the stages of the mining activity. Then, when a mining project arrives at the decommissioning, some major and minor impacts are already solved or minimized.

The mining sector in Canada did some important initiatives and has created special policies directed to some environmental impacts resulting from the mining activity, with the participation of the government, mining companies and other sectors of the society.

One of these is the MEND Association (Mine Environmental Neutral Drainage), to study the acid mine drainage problem. The Mine Environmental Neutral Drainage

was a cooperative of research, financed and administered by the Canadian mining industry, the federal government and some provincial governments (British Columbia, Manitoba, Ontario, Quebec and New Brunswick). The goal of this cooperative was to provide some scientific, technological and economical knowledge to the mining industry and to the government, aiming at the management of the tailings and waste rock deposits, establishing technical measures to be taken avoiding the acid mine drainage generation (Rio Algom Ltd., 1993).

The multistakeholder approach to environmental policy and decision making became inextricably linked with the concept of sustainable development. In this way, the Whitehorse Mining Initiative (Jacob, 1998) became one of the most important initiatives to build alliances and partnerships with other influential groups in the mining sector. It was an initiative proposed by the mining industry and supported by federal, provincial and territorial ministers of mines. About 150 people were involved in WMI, including mining industry executives, officials from the federal government and several provinces and territories, labor unions representing mining workers, environmental groups and aboriginal people. After several discussions, a report containing the vision of the future of the mining industry, some principles, goals, objectives and recommendations was produced.

TABLE 2. Key activities and potential environmental impacts of each phase of mining

Mining phase	Key activities	Potential environmental impacts
Exploration	• Prospecting • Geochemical and geophysical surveys • Drilling and trenching • Staking mining claims	• Generally low or no impact • When exploration reaches a stage of requiring, drilling, or road access, habitat disturbance increases and the discharge of contaminants can occur
Mining and milling	• Feasibility and engineering design studies • Public review • Mine construction and preproduction • Extraction and crushing and/or grinding of ore • Flotation or chemical concentration of ore	• Discharge of acid mine drainage which contains contaminants that are released to surface water and groundwater; particular concerns are related to: – Heavy metals originating in the ore and tailings (can be accelerated by naturally occurring acid generation) – Organic compounds originating in the chemical reagents used in the milling process – Cyanide, particularly from gold milling processes – Ammonia • Alienation of land as a result of waste rock piles and tailing disposal areas • Increased erosion; silting of lakes and streams • Dust and noise
Smelting and refining	• Subject mineral concentrate to high heat to form ingots, bars, etc., of pure metal or alloy	• Discharge of contaminants to air, including heavy metals, organics, and SO_2 • Alienation of land as a result of slag • Indirect impacts as a result of energy consumption (smelting and refining take most of the energy used by mining processes)
Post-operational waste management	• Mine reclamation and abandonment	• Continuing discharge of contaminants to groundwater and surface water (particularly heavy metals when naturally occurring acid generation exists) • Alienation of land and one-time pulse discharge of contaminants and sediment to water as a result of dam failure

Environmental solutions, results and monitoring

Decommissioning of mines leading up to the minimization of the impacts aiming at the reutilization of the area is one of the most important goals of the Canadian mining industry. A lot of alternatives had been developed and evaluated by the mining companies to minimize environmental problems during the decommissioning stage (Menezes, 1998). Nowadays, the acid mine drainage and other effluents pollutants are the biggest challenges of the worldwide mining industry, specially at this stage of decommissioning.

Some Canadian examples will be presented here, from the Abitibi region and the Elliot Lake uranium region. Abitibi is the most important region in Quebec as concerning to mining activities. Elliot Lake was a very important uranium mining region in Ontario. The principal environmental impact in both of these regions is the acid mine drainage generation.

The goal of the developed alternatives is to control acid generation within the tailings to restrict the release of contaminants in seepage and discharge from waste management areas (WMAs).

Aiming at the reduction of this environmental impact the principal alternatives available are: wet cover (flooding tailings); disposal of the tailings in a deep lake; dry cover; underground backfilling; recovering with native plants; multilayer barrier; wet barrier and addition of lime.

Flooding tailings is an option commonly adopted in Canada, however it is not always accessible. The weather and local characteristics, specially precipitation and evaporation rates and the availability of water, have to be extremely evaluated.

Mining companies have to evaluate all the options to decide which one is better to control acid mine drainage in each case. Ten factors must be considered by the mining companies for comparing the various decommissioning options (Rio Algom Ltd., 1993): Water treatment requirements/surface water quality; seepage losses; air emissions; stability of tailings; intrusion; disturbances of areas outside waste management areas; resource recovery; employment opportunities, and public/worker exposure and social impacts. Table 3 summarizes the options selected by companies or government for different cases in Abitibi and Elliot Lake regions, after the consideration of these ten factors (Menezes, 1998).

TABLE 3. Control of acid mine process in tailing areas. Alternatives adopted by Canadian companies

Elliot Lake region - Ontario			
Mine/Company	**Alternative**	**Stages**	**Characteristics**
Quirke I and II/ Rio Algom Ltd. (uranium)	Wet cover (water cover)	• Flooded tailings • Addition of lime • Organic material along the edges.	46 million ton 275 ha 14 cells with difference in levels: 14 m difference in elevation between the west and east ends. 8 low permeability dams. 5 seittling ponds divided by 4 dikes
Panel/Rio Algom Ltd. (uranium)	Wet cover (water cover)	• Flooded tailings • Addition of lime	16 million ton 84 ha south basin 39 ha north basin
Nordic/ Rio Algom Ltd. (uranium)	Recovering Treatment plant to Rio Algom	• Native plants • Barium chloride/lime	12 million ton 10 ha
Elliot Lake region - Ontario			
Mine/Company	**Alternative**	**Stages**	**Characteristics**
Lacnor/Rio Algom Ltd. (uranium)	Recovering	• Native plants	3 million ton Artificial lake
Stanleigh/Rio Algom (uranium)	Wet cover (water cover)	• Flooding tailings	20 million ton 220 ha
Denison/ Denison Mines Ltd. (uranium)	Wet cover (water cover) Recovering Dry cover	• Flooding tailings • Native plants • Soil natural	WMA 1: 60 million ton (240 ha) WMA 2: 3,3 million ton (40 ha)
Abitibi region - Quebec			
Mine/Company	**Alternative**	**Stages**	**Characteristics**
Canadian Malartic/ Ministry of Mineral Resources (golden, silver, nickel, copper)	Sulfurous tailings covering auriferous tailings	Lime and covering	1,3 million ton 70 ha
	Recovering	Native plants	
Barrick/ Barrick Corporation (golden)	Multi-layer recovery	*Lower layer*: sand and gravel stone; *Intermediary layer* (capillary barrier): fine grained tailings; *Higher layer*: fine sand.	8,9 million ton 97 ha
	Recovering	Native plants	
East Sullivan/ Ministry of Natural Resources	Wet barrier	Ligneous residue to maintain anaerobic conditions and mud of purging plant	Layer: 2 m thickness
Lauvicourt Mine/ Resources Aur (copper, zinc)	Underground backfilling	50 % of tailings 80 % of water reused in milling process.	Capacity: 8 million ton 96 ha
	Wet cover (water cover)	Flooded tailings all the time avoiding acid generation	

Sometimes, as to the management of a tailings area, the company or the government has to adopt more than one alternative. For example, in the Quirke tailings, the flooding of the tailings has been done at the same time that organic material has been put over the tailings on the edges of the tailings basin, avoiding the erosion caused by wave action.

Nevertheless, if you consider the concept of zero emission, in all these cases there is still an emission of contaminants to the nature. The alternatives adopted have the pretension of minimizing the impact of the mining activity, reducing the discharge of effluents and controlling the acid mine process.

The Canadian experience at this stage of decommissioning of mines shows that technical solutions are adopted accordingly with political discussion and elaboration of some environmental programs and policies. In that way, the federal and provincial governments are associated with some mining companies to develop an environmental policy directed to the solution or minimization of some major environmental problems, as the acid mine drainage, radioactivity, and heavy metal on the water and soil.

Nowadays, the mining projects must consider the environmental problems since the beginning of the activities, and their solution has to be discussed during the evaluation of the technologies that will be adopted.

CONCLUSIONS

The decommissioning of mines is one of the most important concerns in the worldwide mineral sector. In Canada, this preoccupation has been reflected in the Canadian policies of sustainable development, in their consequent regulations and rules, and in their environmental business policies. As a result, the following actions must be emphasized:

- Multistakeholder approach, including: (a) the elaboration of policies and laws by partnerships between the government, the mining companies and the communities which are affected not at all by mining activity, and (b) some voluntary programs monitored by the Canadian citizen, directed to control some particular environmental impacts, hazards or toxic substances; such as the voluntary emissions reduction program. The MEND and the Whitehorse Mining Initiative are two good examples of actions aiming at characterizing, understanding and minimizing some environmental and management problems in the mining sector.
- To consider as stages of mining activity since the beginning of studies and evaluation of geological deposits at the mining site, until the monitoring and maintenance after closure.
- The characterization of several environmental impacts due to all stages of the mining activity, the environmental standards for a lot of toxic substances, the ways of environmental control and monitoring by Canadian companies and government.
- Some particular policies and laws directed to the stage of decommissioning of mines, specially to the problem of acid mine drainage generation.
- To become available nowadays the application of the concept of polluter-payer, with a compulsory bank deposit by the mining companies before the beginning of mining activities.
- In spite of all these environmental concerns in the Canadian mineral sector, being the acid mine drainage generation a problem for hundreds of years, there is still a long way to path aiming at the introduction of new technologies since the beginning of the mining activity, avoiding several impacts and the use of environmental technologies just as an end-of-pipe technology to minimize this kind of problem.

Nowadays, the decommissioning of mines has also begun to be considered in Brazil as an important stage of the mining activity. Therefore, it is necessary to emphasize the diversity of the Brazilian mining sector and the several kinds and scales of mining activities and companies.

Comparing Canadian and Brazilian initiatives, the following considerations could be done about the Brazilian mineral sector:

- Nowadays, considering all the characteristics and varieties of the Brazilian mineral sector, it is important to elaborate the tools to implement, control and do the fiscalization of the sustainable development policies, making it possible to gather all the sectors of the society which are involved in the mining activity or which are affected, in some way, by it. It is necessary to discuss the real possibilities in all the sector to implement the environmental laws, policies and technological solutions. An agreement of cooperation between the federal government, provincial governments, artesanal and informal sectors, small, medium and large mining companies has to be done, aiming at the elaboration of policies and technologies available to be applied for all the Brazilian mining activities.
- It is necessary an effective characterization of all stages of the Brazilian mining activities, typifying all environmental impacts due to these stages.It is also necessary to review all mining policies and laws, concerning all the environmental impacts due to all the stages and considering all available technologies. The elaboration of any policy must consider some diversities and all stages of all Brazilian mining activities. Although, if there is no technical people trained and prepared to control the fulfillment of these laws and policies and neither able to propose environmental solutions to the mining sector, it will be really difficult to improve the environmental performance in all the stages of mining activities, including the decommissioning of mines.

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- Another important way is the review of the current standards adopted in Brazil to several toxic substances and contaminants.
- Considering directly the acid mine drainage generation, there is no concern in Brazilian regulations and laws about it. Being the acid mine drainage considered as a problem for hundreds of years, the Brazilian government and the mining companies have to discuss the technological solutions and the minimization of this environmental impact more seriously, as in Canada.
- The Brazilian government has to propose environmental policies considering the adoption of clean technologies and the rehabilitation of the mining site since the beginning of the mining activity.

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