

## ENVIRONMENT MINING AND SUSTAINABLE DEVELOPMENT

**Dabi Sanaa<sup>1</sup>, M. Zahraoui<sup>1</sup>, M. El Wartiti<sup>1</sup>, M. Jebrak<sup>2</sup>, F. Z. Nahaoui<sup>1</sup>, D. Fadli<sup>1</sup>**

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**Abstract.** In Morocco there are a series of metal sulphide mineralizations which have been or are exploited by small and medium scale of mining companies. This exploitation, like other equivalent in the world, has a deleterious effect on the environment. The causes of these dangers are simple and can be summarized as follows: one of the most serious problems caused by this mining activity is the incorporation of heavy metals in aqueous media. These metals resulting from the dissolution of minerals that are unsteady with environmental conditions. This is the case of dissolution of a metal sulfide in an oxidizing environment. The main aspects of contamination by mining activity are: the geological processes and the anthropogenic processes.

### **Introduction**

The mining industry is a key factor in the economies of several countries in the world, including Morocco. Indeed there are many mining sites that have been abandoned over the years without rehabilitation, which generate major environmental and socio-economic problems on short and long term.

In Morocco there are a series of metal sulphide mineralizations that have been or are exploited by mining companies on small and medium scale. These exploitations, like other in the world, have a deleterious effect on the environment.

These problems are embodied by their visual impact on the landscape, runoff and groundwater pollution, destruction of natural habitats and soil pollution.

In the socio-economical field the main problem is the lack of integration of mining villagers in sustainable development projects, which is a handicap for local and regional development.

Nowadays the problem of mining is necessary after more, and in order to perform the field of mining, all mining countries and Morocco in particular should focus their efforts towards a true sustainable development approach integrating environmental, social and economical problems.

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<sup>1</sup> PhD., Université Mohammed V Agdal, Faculté des Sciences, Laboratoire de Géologie Appliquée – Rabat.

<sup>2</sup> PhD., UQAM, H3C 3P8, Montréal, Canada

### **1. Impact of mining industry on the environment**

The mining industry in all its “exploration and exploitation” stages of existing minerals in the crust (metallic such as gold and silver or nonmetallic - coal) creates several impacts on the environment from harmful material extraction and disposal of waste from the mine, through the result of transportation of the mineral and its treatment.

The negative repercussions of abandoned mines on the environment are embodied in their visual impact on the landscape, runoff and groundwater pollution, destruction of natural habitats and soil pollution. In the socio-economical field the main problem is the lack of integration of mining villagers in sustainable development projects, which is a handicap for local and regional development.

**1.1. Cases of the most common nuisance in Morocco.** Mineral resources are among the most important natural resources in Morocco, and due to its diverse geological history they represent several genetic provinces that have been exploited over the years.

The mines that were abandoned after stopping their operation have resulted in negative repercussions on their environment and on people in mining villages that have worked in the mines.

The impact of mining industry on the environment in Morocco is evidenced primarily by the problem of acid drainage. There are a multitude of sets of metal sulphide mineralizations that have been or are being exploited by mining companies on small and medium-scale. One of the most serious problems caused by this mining activity is the incorporation of heavy metals in aqueous media. These metals resulting from the dissolution of mineral species aren't in balance with environmental conditions that contains them. This is the case of dissolution of a metal sulfide in an oxidizing environment. The main aspects of contamination by mining activity are:

*The geological processes:* such as the evolution of acid mine drainage resulting from oxidation and leaching of sulphide species by causing a decrease in pH and water contamination by heavy metals such as Cu, Pb, Zn, (Cd) , As, Sb, Hg, etc. and anions such as sulphates, carbonates etc.

*The anthropogenic processes:* such as water contamination due to the use of techniques like leach pile of metal, where the agent may be leaching with sulfuric acid or sodium cyanide. Although there are different ways of mobilizing contaminants such as heavy metals, aquatic environment has a particular relevance because it allows the transport of components on great distances and varied environments.

Acid drainage (Fig 1.a) in mines has a direct influence on soil and water quality which contributes to the destruction of natural habitats and disfigurement of

the landscape surrounding the mine, not to mention its impact on the level and quality of groundwater, as is the case of the small mine Imerja (Bouzniqa region, Morocco) where the groundwater is saturated by waste extraction of barite (Fig 1.b).

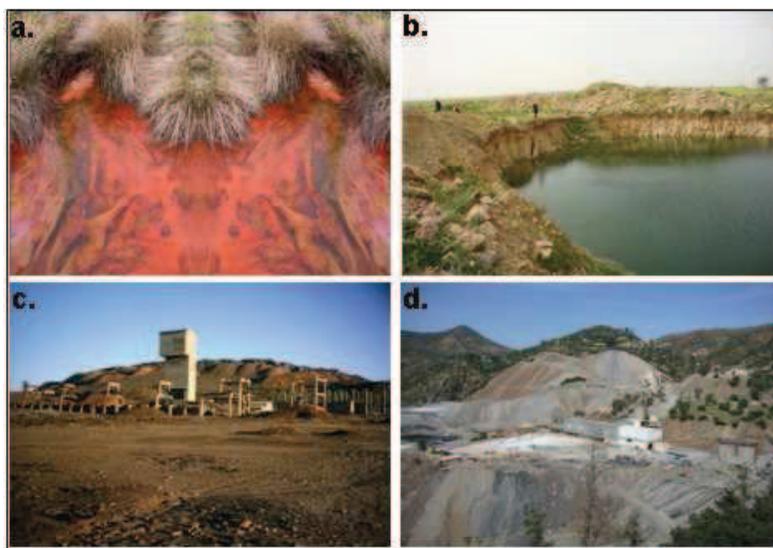


Fig. 1 – Different cases of nuisance the mining industry in Morocco (a. Liquid discharges after production; b. Infiltration of groundwater in Bouzniqa by exploitation of barite, small mine Lmerja, Bouzniqa, 2010 ; c. Kettara abandoned mine – Hakkou and al., 2006; d. Deterioration of vegetation due to mining activity – mine El Hammam, 2010)

Studies from the abandoned mine Zeïd (High Moulouya, Morocco), shows the contamination of surface water and sediments of the region with metal elements. The chemical analysis showed a very high pollution with Pb and As, which can reach  $130 \mu\text{g} / \text{l}$  and  $199.6 \mu\text{g} / \text{l}$  for surface water (EL HACHIMI and al., 2005). The same case was reported at the abandoned mining district Kettara (30 km northwest of the city of Marrakech, Morocco) (Fig 1.c), which releases sulfur-rich acid drainage waters with large concentrations of metals, especially sulfates, aluminum magnesium, and heavy metals (HAKKOU and al., 2006). There are also other problems such as the risk of collapse of quarries, the risk of accidents in abandoned wells, and also the further degradation of vegetation around the mine (fig 1.d).

The adverse impact of mining affects the environment as well as the surrounding population, since they are the source of urban population around the

sites. But after being arrested for operating for a variety of reasons the impact on the mining environment are catastrophic in the absence of rehabilitation and restoration on both the natural environment and on indigenous people especially.

## **2. Mining industry and sustainable development**

In order to address all the problems accompanying the mining industry, Morocco has adopted a policy that aims to integrate mining in the process of social and societal, environmental, and economic sustainable development. This integration was made in light of the new mining law (Dahirs of 2003 and 2006) adapted to an international environment. This is done by adopting a procedure based primarily on laws relating to environmental protection and all international agreements signed by Morocco.

In general during the development of an exploration or mining exploitation, Morocco launched a variety of regulations, administrative measures and techniques for the creation of risk prevention directorate with the aim to regulate the mining industry, so as to preserve the environment at the level of international standards. Economically and culturally, Morocco tries to find a balance between industrial activities, and support the development of the population in the exploited regions.

Morocco is recognized in establishing several encouraging experiments, at several mining sites, on establishing direct and indirect jobs in the area around the mine taking into consideration the plight of miners and their families after mine closure. This policy is also interested in social development by installing infrastructure that will ensure the welfare of mining personnel, and residents around the mine: 'houses, roads, transport, water supply and electricity, "installing medical infrastructure, and education, "mosques, medical services, schools ...", as well as the establishment of associations of mining villages, which will look at integrating women in the course of sustainable development ("literacy programs housewives, creation of community to improve the living standards of their families and create another source of income).

## **3. Results and discussion**

Mining industry has always been an important component in national economic development, by dint of his geological nature setting that fosters the development of mining activity throughout the kingdom. For this reason Morocco is interested more to integrate mining in the process of sustainable development into a perspective that seeks to protect the environment and the wellbeing of the mining villages.

However, several constraints hamper the activities of control and risk prevention in the mining sector, such as inadequate human resources, and insufficient financial resources to provide training to upgrade staff dedicated to

monitoring and risk prevention, as well as for capacity building of the National Laboratory of Energy and Mines, which is responsible for monitoring compliance of mining products prescribed specifications, in anticipation of its accreditation, and to provide entities responsible for control and prevention of risks of material resources necessary.

### Conclusions

Mining exploitation occupies an enormous place in the economy of Morocco, and is regarded as a primary industry of great importance. But mining has several adverse effects on the environment and surrounding population, be it during its period of operation or after closure of the mines, since the majority of mines are left without rehabilitation.

With the intention to perform the field of mining, Morocco must direct its efforts toward a strategy that takes into account the protection of the environment and the development of several steps which would have considered supporting the development of the population in the exploited areas. This will be a source of wealth and prosperity for the environment from a perspective of sustainable development of the mining domain.

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