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Environmental Impact Assessment of Jbel Tirremi Fluorite Deposit Project in Taourirt Region, Morocco

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ABSTRACT

Exploration of mineral resources had been part of the major means to promote economic development in Morocco, but the devastating effect of mining on the environment is inevitable. Based on the factors analysis of the environmental disasters caused by the mining activities, the Jbel Tirremi mine, located in the North-Eastern part of Morocco, North Africa is one of the Open Pit which resulting in an impact on the environmental system. This paper systematically analyzes the influences of Open Pit mining on the land resource, air quality, sound, water resources, ground, species, Socio-economic, ecological system, geological and ecological environment, especially analyzes the effects on the environmental system.

Keywords: open pit, impact on the environmental system, Jbel Tirremi mine, Morocco.

INTRODUCTION

In general, environmental issues concern the protection of living beings (people, animals, and plants) and their biological communities, and their environment. All these elements and their activities form an ecosystem whose survival and balance are provided by the health and quality of components and their exchanges. This ecosystem is active in a given space, characterized by its topography, climate, geology, soil science, etc. Impacts generated by a project can be divided schematically into three groups, (i) it directly endangers the health of humans and the biosphere, affecting the life support systems such as water, air, and soil (Dudka and Adriano, 1997). It can also store the noise and vibration in this category since they are carried by air or soil and their effects are recognized and can be harmful to human health, (ii) it relates to the "land" as support and reflects the activities of man and the biosphere. Indeed, any new project encroaches on the existing space and changes the field of socio-economic activities that take place there. These activities occupy a large part of the territory ranging from agriculture and forestry and leisure travel through sites built, (iii) it relates to the concept of heritage and deals with the natural and historical heritage, natural environments, geomorphological sites, archaeological sites, landscape, the preservation or restoration of it, even putting in value. All environmental impact studies have been providing the effects of mining on the environment system (Pain et al., 1998; White, 1991; Sengupta, 1993; Jimeno et al., 1995; Tadesse, 2000; Gobling, 2001; Haupt et al., 2001; Sare et al., 2001; Blodgett and Kuipers, 2002; Folchi, 2003; Driussi and Jansz, 2006; Casiot et al, 2007; Fernandez-Galvez et al., 2007; Jordanov et al., 2007; Antunes et al., 2008; Bozkurt et al., 2008; Chalupnik and Wysocka, 2008; Hansen et al., 2008; Pereira et al., 2008; Shikazono et al., 2008).

In this paper, several environmental measurements were used to test the impact of the Tirremi mine on the environment and determine the protocol to reduce that impact. The socio-economic impact is also taken into consideration.

GEOLOGY AND GEOGRAPHIC LOCALIZATION OF JBEL TIRREMI FLUORITE PROJECT

The Jbel Tirremi fluorite project lies in the North-Eastern part of Morocco, North Africa (Fig. 1). It is located at a distance of ~14km from Taourirt city between the cities of Fes in the west and Oujda in the east. Jbel Tirremi is a dome ~3km along North-South and ~2km along East-West. It consists of the Jurassic carbonates. These carbonates were crosscut by dykes of Eocene lamprophyre (Giret, 1985; Moussa, 1999; Bouabdellah et al., 2014). The fluorite ore is primarily hosted in the Jurassic carbonates and occurs in open spaces (Karsts, fractures, and faults) oriented NNE-SSW. The grade of fluorite ore ranges from 10 to 80%.

IMPACT OF JBEL TIRREMI MINE ON ENVIRONMENT

Mining project of Jbel Tirremi

A Jbel Tirremi project of mine operations generally includes four phases: i – phase of exploration and research (drilling and boreholes and access tracks); ii – phase of implementation of facilities and infrastructures (building construction and installation of mineral processing facilities, completion of a drainage system, and access to a mining area); iii – the phase of operation [drilling and blasting, extraction and transportation, maintenance of equipment and machinery, mineral processing products (crushing, grinding and floatation), and handling of solids]; and iv – the phase of physiographic changes–abandonment (creation of voids, storage of sterile, and instability), that may bring alterations or impacts on the environment (Fig. 2).

METHODOLOGY

The work, which was undertaken in the Tirremi district is based on (i) the observation field/informal interviews to estimate the impact related to the vibration, the impact on the sound, the species, and the air (There is no air monitoring was made in absence of any industrial activity. It was considered that the air is pure in the region especially in an area of the mountainous field); (ii) the analysis of groundwater and soil samples; and (iii) the interview with mine department to measure the socio-economic impact.

The sampling of water was carried out to characterize the quality at the site of the upcoming project. It involved collecting samples from two wells and five different sources of surface water (Fig. 1). The physicochemical parameters (pH, turbidity, and temperature) were measured in situ, immediately after sample collection. The Analytical methods are: (1) the volume; (2) the atomic absorption;

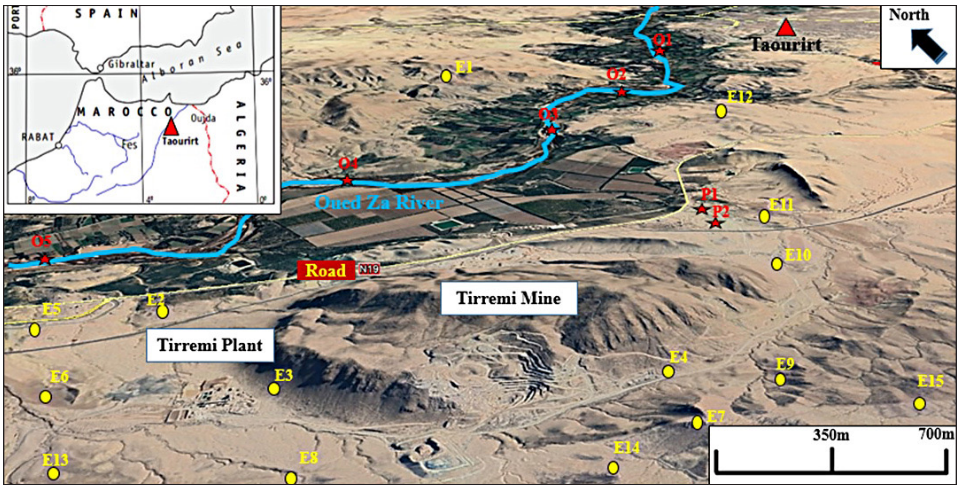

Figure 1. Location of Jbel Tirremi fluorite deposit project in Taourirt region, Morocco, North Africa. (E1 to E15 – samples of soil; P1 and P2 – samples of groundwater; O1 to O5– samples of surface water)

Figure 2. Illustration of some mining activities, Jbel Tirremi project, Morocco; A) exploration (drilling and boreholes); B) access tracks; C) blasting; D) open pit method (drilling and loading); E) dumping; F) panoramic view of GFL-GM Fluorspar plant; G) transportation

(3) the ICP (Inductively Coupled Plasma); and (4) the colorimetric. The parameters analyzed in the laboratory of Gujarat Fluorochemical limited (GFL) are divided into two categories: (i) Major elements (SO_4, NO_3, NO_2, HCO_3, Cl, Ca, Na, K, and Mg); and (ii) Minor elements (Al, Fe, Cd, Cu, Cr, Zn, Pb, As and Ni). A diagnosis of soil quality by referring to international standards has been made. The Soil Geochemical Reference (RPG) is the determination of levels (or concentrations) of major elements and trace elements in soils. The soil samples were collected at varying depths from 10 to 40 cm and analyzed by the ICP (Inductively Coupled Plasma).

RESULTS

The impact on air quality comes from the concentration of dust generated can indeed be greater than 10 times normal in case if there is no mitigation measures are taken. This causes the increase of dust fall on the houses on the surrounding land being in the prevailing wind direction and on the machines. The sources of dust generation include the drilling and blasting, loading and transportation, ore fragmentation (crushing and screening section), track movement of machines, and stocks crushed and dried products. The impact of sound generated from various activities related to mining will cause an increase in noise over the sound environment of the original site. This increase is related to the drilling, firing of explosives during blasting, and operation of compressors, crushers, and pumps.

The impact on water resources of the surface flows is rare and is characterized by their short-lived torrential regimes. Possible impacts on the water environment concern are the water has taken and used in the process of concentration, The requirement to maintain quality by achieving and modification of the physicochemical and biological water, discharges of process water and water contamination by oils and hydrocarbons, runoff and percolation of rainwater on the tailings and the various solid waste. The current result analysis shows that the different parameters are suitable to the standard potability (Table 1). The impact on the ground by the activities of the mining project that will affect the soil will be the stripping for the construction and operation of the mine, the fill materials and construction, Contamination solids: storage of mine tailings and solid waste, and contamination by wastewater discharges and spills of oils and products primarily hydrocarbons. The current soil analysis gives the pH value and the concentration of major and trace elements (Table 2).

The impacts related to vibrations during the operation of blasting are the distance from point measurements, the nature of the geological field, the unit load of explosives, depth of blast holes, method of packing explosives, and accuracy of primers. The impacts on the species living in the region are likely to be minimal as the project-related activities are confined to a small area and are not likely to create hindrance in the living of these species. The socio-economic impact of the mining will allow a significant increase in the production capacity of fluorite in Morocco. This is the first positive impact. The project will also generate direct and indirect jobs. The other positive repercussions, evaluated at (i) local/regional assist to create several permanent workstations, and direct jobs. The local businesses (grocery stores, transportation, housing, etc), and local infrastructures (road, electricity, etc.) will be developed and improved.

Table 1. Water results analysis

Parameters	Unit	P1	P2	Average of O1 to O5	Standard potability
Temperature	°C	21.3	21.3	19.0	-
pH	-	7.6	7.6	7.5	6.5–8.5
Turbidity	NTU	0.80	0.80	5	5
As	µg/ltr	<20	<20	<20	10
Ba	µg/ltr	16	16	41	1000
Cd	µg/ltr	<5	<5	<5	10-50
Cr	µg/ltr	<5	<5	<5	50
Cu	µg/ltr	<5	<5	<5	1,000
Fe	µg/ltr	<10	<10	<10	300
Ni	µg/ltr	<5	<5	<5	50
Pb	µg/ltr	17	17	46	50
Zn	µg/ltr	<5	<5	<5	5,000
Ca	mg/ltr	159	159	90	200
Mg	mg/ltr	301	301	63	100
K	mg/ltr	8	8	5	12
Na	mg/ltr	474	474	89	100
$SO4^-$	mg/ltr	1,273	1,273	319	200
Cl	mg/ltr	1,739	1,739	350	300

Table 2. Soil result analysis

Sample	Latitude (°)	Longitude (°)	Depth of sampling (cm)	pH value	Major elements (%)	Average value (E1 to E15)	Trace elements (ppm)	Average value (E1 to E15)
E1	34.459641	-3.037775	22	9.20	SiO_2	33.07	Ag	24
E2	34.460136	-3.017605	35	9.31	Al_2O_3	4.54	As	<20
E3	34.459146	-3.000439	10	9.43	Fe_2O_3	1.24	Co	10
E4	34.467779	-2.993744	30	8.78	FeO	1.14	Cu	72
E5	34.462542	-2.964218	36	9.07	TiO_2	0.33	Ni	29
E6	34.441097	-3.035715	20	9.25	CaO	27.37	Pb	479
E7	34.435364	-3.011768	30	9.17	MgO	3.39	Zn	138
E8	34.445238	-3.001512	40	9.10	Na_2O	0.30	-	
E9	34.433523	-2.996834	16	9.24	K_2O	0.90		
E10	34.441628	-2.983659	33	9.22	MnO	0.03		
E11	34.432319	-2.980269	28	9.52	P_2O_5	0.08		
E12	34.435222	-2.960270	25	8.56	P_Feu	27.54		
E13	34.424638	-3.012155	30	8.95	$BaSO_4$	<0.10		
E14	34.4241730	-3.012270	30	9.21	$CaCO_3$	47.50		
E15	34.4240820	-3.012455	30	9.40	CaF_2	<0.50		

During the construction phase, the company would recruit the necessary manpower for development works facilities; and (ii) national level, assist in the export of fluorite (97.3% CaF_2) will assist in accounting at the national level by the payment of taxes, and corporate taxes and license. Indirect impacts are a major contribution to this project. It is, for example, the consolidation of national expertise in general and in particular in research and development that can be developed with universities.

RECOMMENDATIONS

The Jbel Tirremi Fluorspar Project is one of a lot of projects in Morocco that affect the various impact on the environment. A summary of the details about an impact operational phase is provided below (Table 3).

The impacts and risks related to operations of the mine have been characterized and prioritized. The assessment and analysis of these impacts have been identified and mitigation/compensation. To mitigate the impacts of operating the mine on the air quality of the site, several measures would be adopted to reduce dust emissions as (i) the protection of all crushing chutes with rubber shields, (ii), the installation of sprinkler systems in smoke on each point of fragmentation, (iii) the installation of shelters winds breezes in receiving hopper, the primary and secondary crushing, and (iv) the reducing the speed of truck

Table 3. Impact matrix – operational phase of the Jbel Tirremi mine

Nuisance	Minor	Moderate	Major	Notes
Air quality				Emissions of dust and gases from machinery but in very small amounts limited fugitive dust (watering tracks)
Surface water				A drainage system will be installed
Wildlife				Insignificant impact
Flora				Insignificant impact
Soil				Insignificant impact
Noise				Mitigated and moderate impact
Landscape				Moderate impact to insignificant
Positive impact	**Minor**	**Moderate**	**Major**	**Notes**
Social				Direct and indirect creation of jobs
Economic				Economic development of the region. Improvement of local public finance by the export of 40,000 tonnes/year to 97.3% of fluorite CaF2

traffic on the tracks. The mitigation of the impact of noise generated by operating activities of mine would include two components: (i) the impact on workers (machinery and blasting); and (ii) the impact on residents surrounding the site during blasting. Several measures would be taken to reduce the impact on workers through the use of personal noise protection tools, the construction of buildings with noise protection techniques, and the planting of vegetation screens for visual and noise protection. The mapping out the noise during the operation of the mine to monitor the effectiveness of measures to reduce noise. To mitigate the risk of contamination of runoff, an internal management system of environmental effluents from different activities will be established. In particular, it will seek to avoid entry of runoff from areas outside the mine and by installing a suitable drainage system. With the adoption of such measures, the impact of mining operations on stormwater runoff will be low and consistent with the concerns of environmental protection. To preserve the quality of groundwater in the region, two measures would be adopted:

- Water would be recovered in settling basins on drum filters. The pulp ground contract would be reduced to zero to arrest the discharge of contaminated liquid in nature. The recovered water would be recycled for reuse.
- The company expects the completion of maintenance and cleaning of equipment of mine in areas equipped with retention tanks and drainage.

To ensure the effectiveness of these measures, a procedure to monitor and control the quality of water wells will be established. This will detect the internal or external origin of possible pollution and monitor the quality of groundwater at the site. It is obvious that the vocation of the site will be changed and that the identity of land will be lost during the mining and processing activities. Plantations should be made taking into account prevailing wind directions and depending on the species tree, shrub, and herbaceous (local and spontaneous) to build a diverse and full-screen fitting into the landscape. Overview of plantation forest species would be defined and adapted to protect the immediate environment and diversity of flora and fauna. The species used must be of multi-purpose while being good windbreak. It is expected that these species would have a rapid growth to ensure: (i) the protective function; (ii) the landscape rehabilitation of the site; and (iii) the development of flora and fauna system. Impact on the species living in the region is likely to be minimal as the project related activities are confined to a small area and are not likely to create hindrance in the living of these species. A typical impact of mining is expected in the region. However, mining operation and even the beneficiation plant could be stated to be small scale considering the volumes being handled and associated facilities, equipment, etc. On account of this, it is generally felt that mitigation of impact on the environment is very much possible and adherence to Moroccan or international standards could be achievable by taking suitable measures.

CONCLUSIONS

A typical impact of mining is expected in the region. However, mining operation and even the beneficiation plant could be stated to be small scale considering the volumes being handled and associated facilities, equipment, etc. On account of this, it is generally felt that mitigation of impact on the environment is very much possible and adherence to Moroccan or international standards could be achievable by taking suitable measures. The positive socio-economic impact can make the Jbel Tirremi mine one of the best generators of Jobs in the Taourirt region.

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