CONSIDERATIONS ON POSSIBILITIES OF UNDERGROUND MINING AND PROCESSING OF NON-ENERGY RAW MINERALS IN ORDER TO REDUCE THE ENVIRONMENTAL IMPACTS

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Abstract: In recent years, across Europe and Romania, in particular, it has emerged and continues to exist an opposition to the "heavy" industries: mining, metallurgy, manufacturing, etc., motivated, mainly, by their impact on the environment. However, some countries such as the US, China, India, Australia, Russia, etc have continued or even expanded these industries and they are proving to be viable, progress engines while Europe and Romania became tributaries to importations.
The innovative project seeks to develop a concept of mining activity with minimal impact on ecological footprint, which integrates both extraction and processing. This new approach involves changing the relationship between industrial activity, community and environment through a training work, increasing public awareness in the interests of transparency and acceptance of the need of mineral resources exploitation and valorisation, environmental frendly.
Key words: mining activities, underground exploitation and processing, backfilling, minimal impact on the environment

1. Introduction

Mining industry is an intensive activity that creates large volumes of wastes containing various substances. Quarries, ponds, stocks of ore or tailings deposits that extend over large areas (agriculture, forestry, etc.) are significant sources of pollution and toxic waste. On the other hand, underground spaces in activity or abandoned, affecting the surface by subsidence.

Consequently, commodity prices have risen significantly, given increased production and investment in the exploitation and the share price of raw materials in finished products that includes metal to four times between 2003 and 2013, while the labor share has remained almost unchanged. (Peeters, 2014)

While the global production of minerals (excluding bauxite) grows from 11.3 billion tons in 2000-to 16.86 billion tons in 2012, the European production declined from 1.749 billion tons to 1.6 billion in the same period.

Table 1. *Mineral production in Europe and worldwide*

Year	Mineral production (excluding bauxite) (billion tons)	
	World wide	Europe
2000	11.3	1.749
2004	13.1	1.77
2008	15.033	1.69
2012	16.86	1.6

Between 2008 and 2012, the world production has increased significantly for main metals: Fe production with 28.22%; Cu with 7.19%; bauxite with 32.16%; 25.22% Pb; 13.24% Zn; Au 17.8% and 17.17% Ag. (Reichl et al, 2014)

In the last twenty years the energy production increased by 50% but 1.3 billion people still have a lack access to electricity. The electric energy production and its transportation need a significant quantity of metals.

The need for mineral resources is growing significantly, it is necessary to find new sources (reserves) and technologies with minimal impact on the environment to minimize the risk of this industry.

The study aims at developing concepts for exploitation and processing technologies, environmental friendly. The various issues covered are: opening, training and exploitation; dimensioning and geometry of underground space for a given production capacity; underground plant construction and stability; underground ore processing; transport to the surface of metal concentrates; the backfilling study.

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The aim of this work is to develop a sustainable mining by reducing the area occupied by mining and landscape and environmental impact reduction.

2. Database for developing the new concept of mining activity

Rising prices and an increasing need to ensure raw materials are, for European countries, the issue to operating and mining their resources. It requires the exploitation of deposits with low and/or small content. A large number of deposits have been identified in recent years and many of them have begun operation or are in the design phase. It may be noted that the development of this activity creates jobs and income for many European citizens, especially in rural areas. There are, however, several key points that must be maintained to keep the current success of mining. It requires a sustainable mining business that includes public information and education in order to improve the public opinion, to optimize land use (reducing surface mining construction, mining waste deposits, etc.) and environmental protection.

Europe is beginning to recognize the role of mineral resources exploitation in the development of the Community and Member States' internal development. One of the first consequences is to ensure a balance between environmental policy and industrial development policy, emphasizing the need to reduce dependence on large producers of raw materials in the world. There are administrative obstacles, it is necessary to improve the image of the mining sector; there is a need for skilled labor, management techniques, education and training. For this purpose in the Official Journal U.E. (2009 / C27/19) it was published the opinion of the European Economic and Social Committee (EESC) on Non-energy mining industry in Europe.

These documents detail the role of minerals in sustainable community development and quality of life, classifying the non-energy minerals: metallic minerals (copper, iron, silver, etc.), industrial minerals (salt, feldspar, kaolin, etc..) and construction minerals. Europe's capacity to ensure supply with metallic minerals from native extraction is very limited (in 2004 it was imported 177 million tons, while production was 30 million). The document states that many Europeans do not recognize the importance of mining, but in the future sustainable development of Europe will depend heavily on locally extracted minerals, while a mineral demand from countries like China and India could affect security of supply EU. Promoting renewable energy and energy efficiency lead to technological equipment, incorporating large amounts of metals with a significant proportion of rare and precious metals, which are indispensable. Supply security of European industries can be improved by investment in mining sector of new Member States geological potential with respect to the countries of Eastern Europe, where the geological structure always allowed mining activities. In these countries the mining sector was underfunded and private investment is essential. Development of extractive industry generates jobs in other industries; usually an extraction operation creates an average of four times more direct than indirect jobs in the region where it is located. Regional growth potential is considerable, especially in areas less accessible to other forms of economic development.

3. Current conflicts in mining

The public interest on risks posed by mining and processing is fully justified. It becomes the factor of mobilization of the industry and authorities to find solutions to mitigate these risks. It is certain that there is no miraculous solution to ensure safety in human activity on the planet. Man was exposed always to risks from their actions or natural hazards.

Mineral exploitation and processing of metals by man endures in ancient times and will continue in the future. Fear of risks faced by the population in the vicinity of mining and metallurgical activities can be limited by access to information on projects to be implemented through public debates in civilized manner in order to promote truth and transparency.

Systematic rejection of mining projects by public opinion, rejecting taken and implemented by the authorities, lead to deprivation of resources for human evolution and exposure to higher economic, social and environmental risk in the future. Lately, the European Community was often facing to public pressure against mining projects.

An alternative to diminish the environmental impact of mining activity and reduce pressure of public opinion is the underground ore mineral exploitation, processing and backfilling activity. In this way the volume of mining waste deposits and the occupied areas are significantly reduced, eliminating surface construction of processing plant. Reducing these processing and storage areas - they do not affect the ecological footprint – it become available for other purposes: industry, agriculture, forestry, recreation, etc.. Costs land acquisition and surface construction decrease significantly by placing the activity in underground. Mining waste material stored - usually - on the surface can be used to backfill the underground

spaces remaining after operation, reducing the risk of land subsidence and damages.

Long-term objectives of the research are to promote sustainability and the responsible use of land, reduce environmental impact and improve public awareness on mining. The purpose of research is to study possibilities to develop underground mining – mining, processing and backfilling – in order to optimize land use, to reduce areas covered by mining deposits and wastewater volumes.

Scientific objectives of the research are specifically related to the placement of mining and processing activity in underground correlated with sustainable mining operations, environmental protection and public awareness.

4. Expected results

This report aims to provide a scientific basis for sustainable, technical information for stakeholders, national and European environmental legislative bodies, about the possibility of developing an underground – mining, processing and backfilling – activity, to reduce costs with the land acquisition, protecting the surface by backfilling underground spaces, reducing the areas occupied by surface mining construction, mining waste deposits, reducing waste water volumes, reducing the environmental impact and improving the image of this activity.

The majority of mining perimeters are closed or in conservation offering the possibility and conditions for underground exploitation and processing. Evaluation of economic and environmental impact of this concept will be done taking into account several important facts: awareness of the national resources value and importance of its exploitation; reducing dependence on the importation of mineral resources for economic activity; minimizing the surface occupied by the mining activities, visual impacts, reducing the cost of properties acquisition; improving public awareness and local communities related to the mining activity.

5. Stages in the development of the mining project

5.1 Data base

To create a database and implementation of feasibility studies it will be studied ores in different stages: prospection and/or exploration; open and/or prepared (those that have not come to be exploited); partially used: those whose stocks have been partially exploited, the rest being partially opened and/or prepared.

Mining activity in Romania has included research/exploration and exploitation. Research and exploration were conducted in prospecting and exploration companies (IPEG). Technical documentation relating to reserves, contents, or work situation exist on the archives of these institutions or to National Agency for Mineral Resources (NAMR). The exploitation used to be done within mining enterprises (EM) in mining companies with regional expansion.

Setting up the database is timely and very important to assess the potential for exploitation and valorization of non-energy mineral resources. National mineral resources situation in various stages is particularly complex.

For the work identification and classification, depending on the stage of research/exploitation, requests will be submitted to the authorities that hold information about the situation of deposits: reserves, contents, research stages/exploitation. Information will be completed with the legal status of mining perimeters or companies that hold licenses and permits. The study is focused on underground exploitable reserves. Geometric data will be collected on the ore-thickness, slope, depth and extension, hydrogeological data, etc.

To carry out pre-feasibility studies of the ores contained in the database it will be analyzed and forecasted the market of non energetic mining products. Depending on the content, quality and geo-mining conditions it will study the pre-feasibility exploitation, including production capacity.

Based on data obtained in the next stages of the study (method of mining, processing, etc.) the feasibility studies will be completed.

5.2 Underground exploitation of non energetic ores

The research in the project is focused on ores opening and preparing scheme optimization, analyzing applicable exploitation methods for ores specific conditions which include underground space filling operation using ore processing waste.

Classic exploitation consists of underground ore blasting, its transportation to the processing plant in close proximity to the mine and set up storage facilities result in surface (in general). Underground processing and filling operation with the sterile product can significantly lessen the environmental impact of mining activities.

The approach begins with the study of research opening to work schemes that fall under the proposed conditions.

Lately, the open schemes were chosen following the large production capacities and optimizing ore transportation to the surface.

The proposed solution suppresses the carriage to the surface of large volumes of ore, reducing this activity to transport to the surface of mining concentrates, personnel access, materials supply and the equipment introduction.

After the identification of the applicable exploitation methods, the opening schema chosen will be completed with a preparation scheme.

Further, it will be studied applicable exploitation methods. Their particularity is the underground filling operation, after exploitation. It will be chosen the optimum method for each of the ore body types, identified and classified. It is about the recommendation of optimal operation methods for a particular ore type, so that the results obtained can be organized as a guide.

It will be identify execution technologies for underground work: digging galleries, vertical or inclined mining works, stopping. After choosing the initiation/preparation and exploitation method it will be described digging technology, the support system, arranging and recording of underground conditions and safety.

Identifying execution technologies includes the choice of equipment type for digging methods proposed (drilling-blasting equipment, loading/discharging material, etc.), type of support, water discharges, etc.

It will be carried out a study of the technical solutions for the air-conditioning of the underground spaces in order to provide optimum working conditions with minimum expense and maximum safety.

5.3 Dimensioning, construction and stability of underground processing plant

The objectives of this phase are identifing the optimal position in the opening scheme for positioning the underground processing plant, dimensioning its underground space based on production capacity set out in the feasibility study and identification of the optimum technology of execution and support system of underground plant, taking into account its size.

It will be seted out the criteria for the choice of the processing plant position in best geological structures to optimize the support system costs and preserveing the transportation distance on minimum cost limits. Underground spaces safety requires detailed analysis of the excavation possibilities, support system possibilities, air-conditioning, etc.

The positioning of underground processing plant will follow the two prerequisites: a favorable geological structure involving minimum stabilization and safety costs; optimization of underground ore and waste transportation.

After optimizing the mine production capacity, a correlation with processing work through technical solutions that minimise space technology in optimal safety conditions will be done.

Afterwards, it will be tackled the problem stability and support system of the underground plant space. The problems of the large-size excavations stability are complex and there are methods for calculating the appropriate support system. These are analytical, numerical and empirical and are used in conjunction.

Execution technologies for underground large spaces require excavation in several stages, with splitting the total cross section in lower sections which facilitates both excavation and transportation of excavated material and space support system. The purpose of this study will be the elaboration of perforation and blasting monography which synthesizes the results of all calculations.

The large size of the location entail a separate approach of air-conditioning scheme, its integration on ventilation scheme of other spaces and in the general scheme of the mine's ventilation. It will also be established the optimal type of lighting and the arrangement of utilities in processing space.

5.4 Non energetic ore processing in undergound plant

The main objective of this research phase is the detailed description of ore processing having regard to the water management conditions in underground mining, reducing the mine water volume and tailings resulted from ore processing, discharged at surface.

It will be analyzed and improved the layout scheme of crushing, grinding and concentration/floating installations, etc., including modern technology of concentration with possibilities to use mine water in technological flow.

In terms of production capacity and the ore mineralogical conditions it will be designed the technology flow which involves the choice of technology, equipment and operations sequence, taking into account the particularity of the underground processing, the possibilities to use the mine water in technological flow and manage it environmental safely.

Depending on the particle size of the material resulting from processing operation, it will be analyzed the filling operation from material transportation to draining water.

5.5 Environmental impact assessment of the non energetic minerals underground exploitation and processing

The objectives of this phase are: minimize environmental impact and improve mining activity image, reducing interference with local communities, authorities and environmental NGOs through minimizing the surface manifestations of the mining activity.

The purpose of this research phase is the development of technical solutions that minimise the impact of mining activities on the environment. The negative image about mining activity was created by accidents occurring to mining waste deposits, produced - mainly – by their physical and chemical stability as well as the visual impact of excavation, of moving and storage of large volumes of mining mass.

Environmental impact assessment of the mining project will use specific methods to highlight the minimal effects of proposed solution compared to classic exploitation, through a comparative analysis between classical mining and processing solutions and the innovative project. The study is a comparison between two situations: classic exploitation and the inovative project. In this way it will be made two separate analyses for the same capacity and the similar geological conditions, mining and processing, in order to quantify the results and to make possible the comparison.

To bring to the attention of the public and other stakeholders the benefits of the project, it will be carried out presentations in which will be integrated informative brochures concerning the need for mineral resources in the development of human society, to motivate the importance and necessity of mining activity, awareness that any industrial activity entails risks which must be minimized and undertaken by designers and performers, understood and accepted by the general public and authorities.

6. Situation of mining activity in Romania in the EU context

In the controversial economic context after the revolution, Romanian industry began to be considered - in order to be redeemed at any price - a "heap of scrap metal " and the mining industry as a " black hole "in which faded without profit, oversized subsidies with devastating environmental effects.

In Romania, all these prerequisites have made of mining a "detrimental" activity, while worldwide, the development of mineral resources exploitation continued, representing the engine of national economy in many countries outside Europe, even in times of crisis. The negative image created by political game from the 90s - when miners were involved in riots and handled, subject to the public everlasting odium - which was complemented by the philosophy of the European Community, which believed that it no longer requires the exploitation of mineral resources. Europe declare itself environmentalist, "a lady with white collar," which is not dirty with mining and metallurgical activities, preferring to create high technology, ignoring the birth of empires with "white collars" and "blue collars" (metaphors used by Alvin Toffler), with an alert rate of development, defying the crisis.

This was the position of the Romanian mining industry, undermined from inside and aided to fall into the chasm, from outside.

There are many regions in Romania in this situation, including the region of Baia Mare, Borşa, Apuseni Mountains area etc. The opinion of the Economic and Social Committee urges the European Commission to recommend a series of rules that promote and facilitate the extractive industry, such as: improving the legal framework and permitting system, increasing the compatibility of extraction with environmental protection, improving the information quality about minerals. Among those recommendations there is facilitating and providing incentives for exploration, reducing duration the of land purchase, encouraging the creation of enterprises and attracting exploration companies from outside EC. Supporting the principle of proximity in mineral supply within the Eu, will reduce the effect of "not in my backyard", thereby increasing the degree of community acceptance of the extractive industry.

7. Conclusions

Any civilization is builted and evolves based on the exploitation and valorisation of the mineral resources. In recent years, across Europe and Romania, in particular, it has emerged and continues to exist an opposition to the "heavy" industries: mining, metallurgy, manufacturing, etc., motivated, mainly, by their impact on the environment. However, some countries such as the US, China, India, Australia, Russia, etc have continued or even expanded these industries and they are proving to be viable, progress engines while Europe and Romania became tributaries to importations.

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involves changing the relationship between industrial activity, community and environment through a training work, increasing public awareness in the interests of transparency and acceptance of the need of mineral resources exploitation and valorisation, environmental frendly.

The investor will be more free in implementing such a project, not under the pressure of a sustained hostile public opinion or negative image promoted and amplified by different structures.

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