MINE SURVEYING

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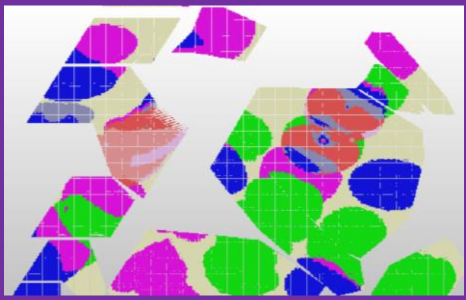

MINERAL RESOURCE ESTIMATION OF FE/NI DEPOSIT IN SKROSKA MINE USING MICROMINE

Arbi SHEHU

Dr. Arbi SHEHU
Department of Industrial Engineering, Faculty of Engineering;
Canadian Institute of Technology, Tirana, ALBANIA
Email:arbishehu@gmail.com;
Tel:+355692077033

ABSTRACT

The development of GIS-based technology, as well as its application in exploration of mineral resources, has brought new approaches for the revision of conserved mines with future exploitation possibilities. In this way of thinking, the process of studying the deposit of Fe / Ni in Skroskë at Korça region has started. Through the development of geological data bases, 3D modeling and interpretations in Mircromine, and international standards applications in the field of mine resource evaluation, it was made possible to determine the appropriate conditions for the estimation of Fe / Ni mineral resources in this deposit.

This paper will bring at hand the final step of a long study, which aimed the comparison of the new and the old techniques in mine modelling, mineral resource estimation and exploration. This last part will include the identification and positioning of ore bodies, capacity and quantities of mineral reserves, and the technical reporting based on international standards.

***Keywords*:** Micromine, Resource Estimation, GIS.

1. INTRODUCTION

During the development of the mining activity there are two important stages in the resources estimation. As early as during the first phase of the exploration, after the drilling process and their interpretation are closed, it is possible to conduct a preliminary resource estimation for the studied deposit. While in the second phase that of mine exploitation and underground works construction, it is possible to update the first estimation carried out with the data obtained during the exploitation.

Once the first exploitation data has been prepared and calculated reserves extracted from the mine, it is possible to compare the coefficient of error between the first resource estimation and the calculation extracted reserves. This procedure is advised to be done for certain areas where the exploitation was done but also at the end of the mining activity. Since the estimation of resources during the exploration phase is based on partial data, it will be presented as an inventory of the mineralized body and not as the factual condition of the ore found in the deposit. This evidence makes this variable assessment not only during the exploitation phase but also in the processing of minerals up to the account of its economic value. (Moon, et al., 2006)

1.1 Skroska Mine

Skroska Mine is located in the south-eastern part of Albania, with a geographical extension of 1,66 Km2. Situated close to the national road and the railway line, with a strong position and an easy access for exploitation. The history of this mine dates to the early 1980s, where the first research and discovery works were completed, which followed the opening of the mine in 1985, and then its conservation in the early 1990s.

The work for this study has started as a result of the increased impact of information technology in the field of natural resources. Two more works have been carried out before this paper, which have described in detail the processes developed in Micromine for the creation of mining databases and 3D modeling of mining works and deposit of Skroska.

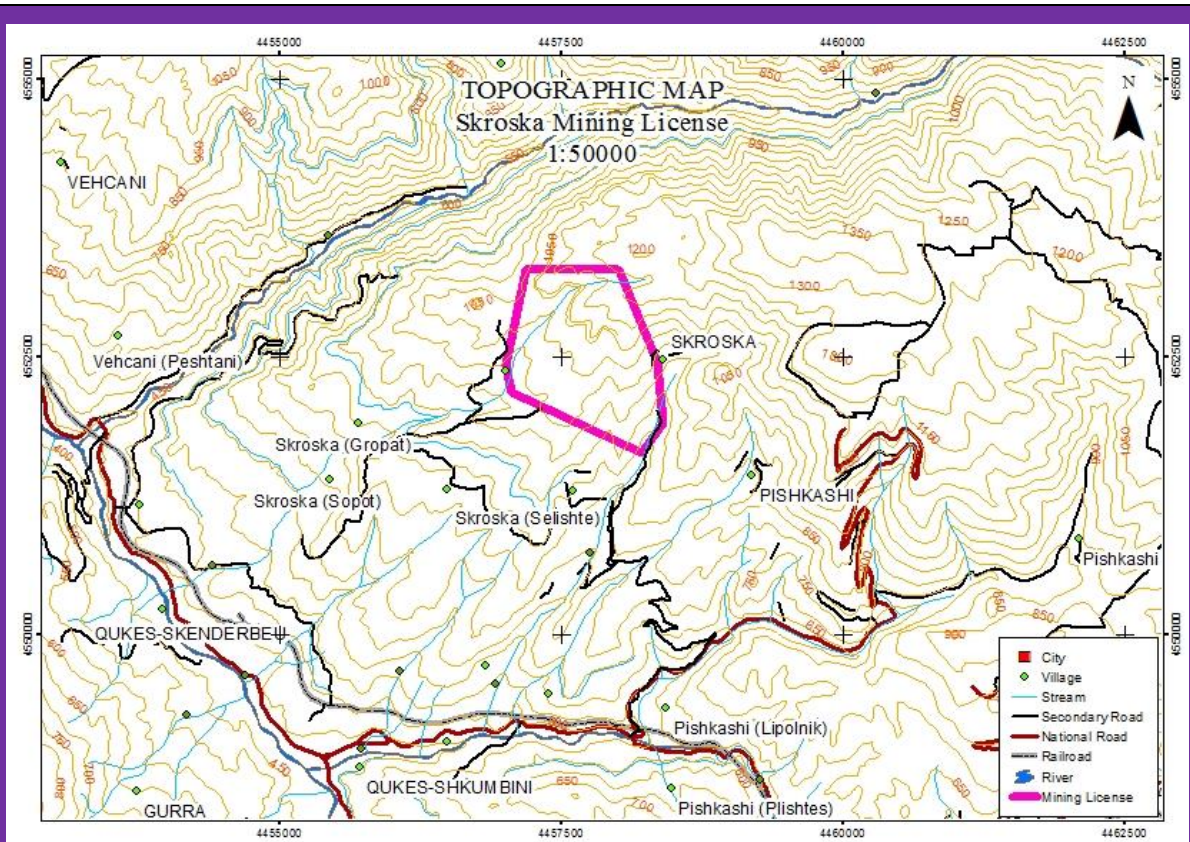

Figure 1 *Skroska Mine Topographic Map*

2. MATERIALS AND METHODS

Micromine software, besides the geological and mining field, is also focused on the resource estimation and categorization. Regarding the estimation, this software enables the calculation of volumes and tonnage according to the geographical distribution based on the position and distribution of the performed drilling. The realization of this method will initially involve the creation of mining data, the modeling of ore bodies and then the estimation of the reserves in them. After the preparation of the mining data and the interpretation of the model, the last process will be the estimation of the resources, which is divided into 3 parts and each of them applies several procedures.

Figure 2 *Resource Estimation Process in Micromine*

2.1 Mineral Resource Estimation Process

Data preparation will be the first phase of the estimation process in Micromine. This phase includes two majors steps, Compositing and Global Reference Estimation.

a. Compositing

Resource Estimation process will be based upon the data created on the beginning of the study. In this case the results from drilling which are given into the Assay Database are divided in several sequences that vary from 0.1m to 10m long. The second fact to be considered will be the calculation method. In this case Micromine, has the possibility to calculate the data with IDW or Kriging method. Both use the geographical position of block center with respect to the drilling intervals. Given these two factors, if we used the original drilling data with the both calculation method, then the generated blocks would have disturbances in the distribution of the length intervals with the size of the blocks generated, then the calculation of the reserves and of the generated data would be wrong. For this reason, it is possible to realize the data compositing process which realizes the distribution of the intervals of puncture at the same length in order that the ratio between them and the blocks be in a fair proportion.

This procedure will need the average length of the drilling intervals which should be determined initially and will serve for further breakdown of the intervals. Based on the results, it is advisable that the length of time intervals for calculating the reserves should be 5m. The computed interval calculation will also automatically compute the XYZ coordinates for the center of the interval.

b. Global Reference Estimation

After the interval compositing process has been completed and before starting the part of the block model construction, it is appropriate to calculate the tonnage and texture quality of the model created with Wireframe beforehand. This calculation procedure shall be accounted for as the Global Reference Calculation and includes the calculation of the entire tonnage of the modeled source and the computation of the quality according to the composite intervals. The generated calculation will serve to evaluate at the end of the process which part is accounted for as a reserve and how much remains has been left without counting. The tonnage calculation is based on the metal volume weight, which is 1.9 and is taken from the analyzes carried out in Skroska mine.

2.2. Block and Sub-Block Modelling

The block model will present the model of the constructed Wireframe through quadratic geometric shapes so distributed to meet the body's space. As an example, for this potential, the body volume buildup of cube formwork is considered. At the boundaries of the ore body, breaks the blocks into smaller blocks in order to fulfill the remaining empty space, a process called sub-blocks.

Through this construction it is possible to know the dimensions of the blocks by calculating their volume, which by multiplying with the density of the ore will give us the tonnage. By collecting the values for each building block, it will be possible to find the tonsil of the entire mining body. The last remaining process will be to calculate the quality for each block and sub block.

a. Block Model Size

The Block Model will be initially determined depending on the boundaries of the Wireframe built-in model. As for the size of blocks to be created there are no fixed rules, but only some tips that can be given in relation to project elements, the frequency of drilling, the variability of the resource, the size of the number or the size of the final file to be created. Beside the orientation that can be obtained from these elements, accurate determination of the size of the block will be based more on the knowledge we have on the project and the deposit.

b. Sub Blocking

Apart from the construction of the blocks, for the filling of the remaining empty spaces, it is possible to construct the smaller blocks that will be able to fill these spaces in the ends. The disadvantage of this procedure is that even unnecessary blocks inside the body are created. To accomplish this, it is necessary to use sub-blocks, which are created at the ends of the body and not inside it. Also, sub-blocks will be created only in those cases where they have the space available and the connection to the initial block. Determining the size of the sub-blocks is the same as defining the size of the initial blocks, but in this case the size will be smaller than the initial one.

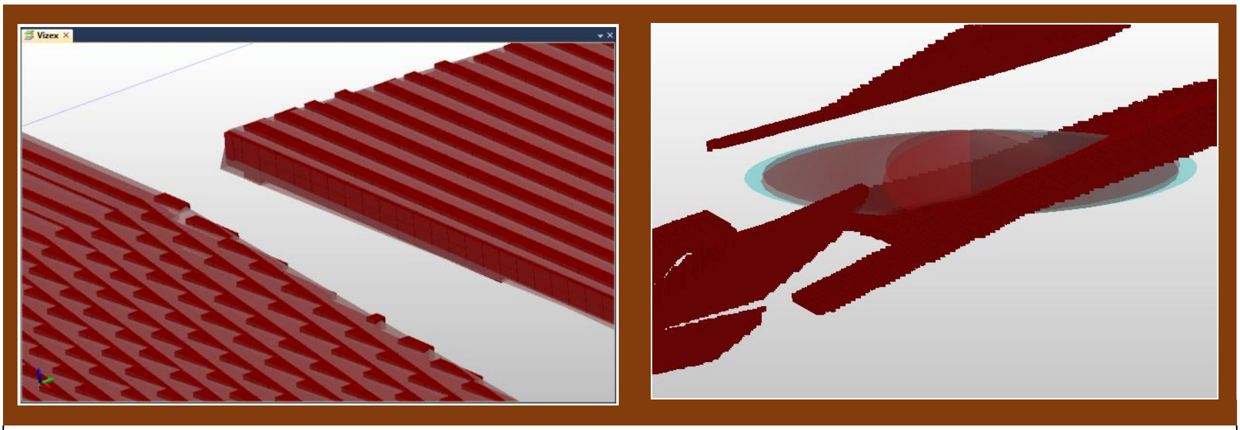

Figure 3 *Block Modeling and Search Ellipsoid Process*

2.3 Resource Estimation

Resource Estimation process will be done based on a specific weight, which is evidenced by the analyzes made for the mines sample. The recognition of this value is mandatory for calculating the final tonnage of the source. Another important element for estimating the reserves in Micromine is also the exact definition of the required space. Given that Micromine software is GIS based, it brings a new element for valuing reserves unlike historical methods. This is one of the reasons why this program is not based on the calculation made based on global references, but to another calculation method based on factual data of the source rather than the different interpretations. It is a matter of calculations based on the location, which means that the blocks will be given those data that are spatially linked to the drilling intervals. This connection will be realized by determining the required space, which is evidenced by an ellipsoid, allowing Micromine to locate drilling logs that affect the estimation of the reserves.

a. Search Ellipsoid

Since the ellipsoid has a 3D shape than three axes will have to be defined for its construction. The determination of these axes will be made based on the distance between the drilling and the distance between the cross sections and its thickness will be based on the thickness of the ore body. The length of the accesses must be in the measuring unit of the built project, which in this case will be in meters. Axes 1 and 2 will be positioned right angled and their length should form an ellipsoid, while the length of axis 3 can be determined simply through the length of the second axes. In this way, the length of Axis 1 will be greater than the other axes, followed by Axis 2 and finally Axis 3. In the determination of the ellipsoid. Other data concerning the ore body will be the Deep Angle and Azimuth. The creation of ellipsoid in Micromine serves for several purposes. First, for determining the required space during an IDW and Kriging method interpolation. Secondly, during geostatistical analysis, the ellipsoid can determine the analysis of half-variogram of a double control.

b. Data Interpolation

Most of the models used for resource estimation, use classical or somewhat geostatistical methods, which are largely based or linked in some way with the distance between the intervals caught by surface drilling or surveying. Unlike these methods, Micromine enables the use of an inverse distances method known as IDW. This method gives priority to the data position by weighing the distance inversely from the drilling intervals in the direction of the model block. In this method an important role plays the search space which will serve as the selection element for the blocks around the drilling interval. Through the IDW method, the previously defined ellipse will indicate which blocks will receive information from the intervals they are approaching. Also, in the creation of the ellipsoid is defined the minimum number of drilling that may fall within it, this also comes because of determining the distance between the drilling, which as a result will have a minimum of 1 drilling and a maximum of 3.

c. Estimation Proces

At the end of the block interpolation process, regardless of the methodology used, it is possible to calculate volumes and tonnage. Compared to the first calculation this time, the calculation will be made only for those blocks that have obtained the result during the interpolation performed. The data obtained from this calculation can be compared to the data gained from the global approach obtained through initial modeling.

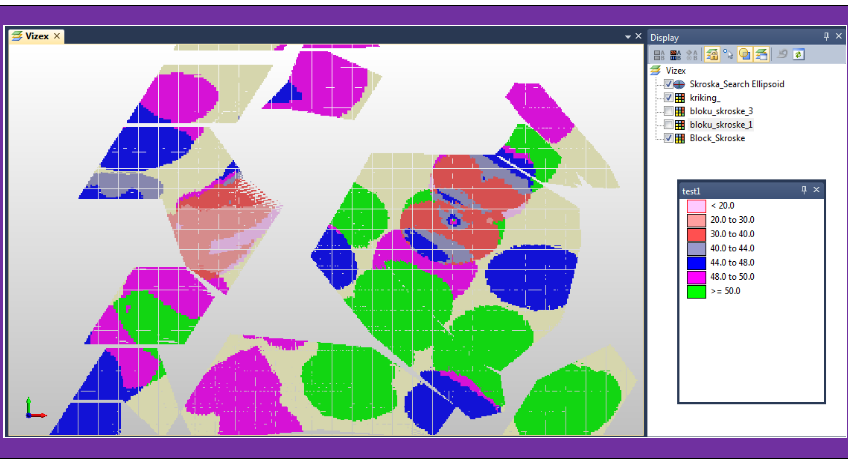

Figure 4 *Resource Estimation of Ore Bodies of Skroska Mine*

3. RESULTS

GIS software have different usage and some of them are focused only in specific areas. Exactly one of them is Micromine, which, unlike other GIS software, is focused on geology and mining, in modeling and analyzing them, and in estimating and modeling the use of resources. The use of this software has found place in many investments in the world, and the methods used by it in assessing the reserves are considered as simple but practical and based solely on secure data collected during the exploration or exploitation phase.

The process of resource estimation through Micromine is carried out using the Block Model application method that implements a block model inside the 3D ore body interpretation. The following calculation are carried out according to the application of the IDW or Kriging method, which realizes the quality distribution based on the distance of the blocks from the data source.

Once the methods have been applied and the processes for modeling and evaluating the nickel iron mine in Skroka can be achieved, the final results of this study can be provided. These results generated by the Micromine can be compared to the previous results calculated from the classical method. For the calculation of these results, volume weight of 2.73 was taken into account and five categories of grading were performed. These results can be recalculated continuously with different volumetric values, depending on the knowledge of the source or the updated mineral analysis.

Table 1 *Resource Estimation of Skroska Mine*

Quality (%)		Volume (Ton)	Resources (Ton)	Spec. Weight	Fe (%)	Ni (%)	SiO_2 (%)
0.00	20.00	32257.81	88063.83	2.73	17.41	0.90	7.55
20.00	40.00	280125.00	764741.25	2.73	28.92	0.93	7.12
40.00	42.00	97742.19	266836.17	2.73	41.37	1.19	6.30
42.00	44.00	144343.75	394058.44	2.73	42.65	0.89	8.74
44.00	46.00	634 054.69	1730969.30	2.73	45.11	1.00	6.59
46.00	48.00	601562.50	1642265.63	2.73	46.94	0.94	6.53
48.00	50.00	1851398.44	5054317.73	2.73	49.16	0.95	4.87
50.00	99.00	1612359.38	4401741.09	2.73	51.68	1.01	4.17
Total	**5,253,843.76**	**14,342,993.44**					

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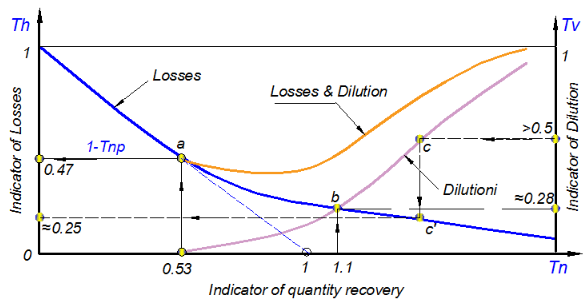
AUTHORS BIO

Dr. Arbi Shehu is a lecturer in the Department of Industrial Engineering at the Canadian Institute of Technology in Tirana. He holds a PhD degree in “Geoscience, Natural Resources and Environment”, and Master of Science in “Natural Resource Engineering/ Geomatics”, and a Bachelor of Science on “Geoinformatic Engineering”. He has 10 years of experience in international and national institutions in Albania. These experience include different projects in Oil and Gas, Mineral Exploration and Exploitation, Property and Land use, Urban and Territorial Planning.



INDICATORS OF LOSSES AND DILUTION IN A MINING ACTIVITY


Skënder LIPO


Nevina POLO


Gëzim BALLA

Prof.as. Dr. Skënder Lipo[1]
MSc. Nevina Polo[2]
Msc. Eng. Gëzim Balla[3]
[1,2] Faculty of Geology and Mine, Polytechnic University of Tirana, Albania
E-mail: liposkender@yahoo.com;
Tel:+355692127540
E-mail: n_nevi@yahoo.com
[2]Chromium Mine Katjel, Albania
E-mail: gezimballa69@gmail.com

ABSTRACT

Mining assets are unrepeatable and an important source for the development of a country. Their industrial exploitation is based on mining, metallurgical, economic, environmental, and state social factors. Mining factors such as production capacities, mining costs and the realization of indicators of losses and dilution are the determinants of the success of a mining activity. The value of a mining project, which is based on limited reserves, is very sensitive to losses indicators and dilution, as each lost tonnage of minerals affects the value of the ore deposit. In this article, we will discuss the degree of impact of the above factors, while paying attention to achieving the most optimal indicators of losses and dilution.

In mining activities with limited reserves and where the value of a tone of mineral extracted is high, it is required to increase the recovery / losses ratio and maintaining a fair ratio between the indicators of losses and dilution.

INTRODUCTION

The earth's rock material, where a mineral is found, form mineral deposits, the object of the mining and mineral processing industry. The distribution of mineralization within a mining deposit is very heterogeneous and creates differ-rent concentrations of mineralization. The concentration rate is the grade of the metal content. When the mineralized material has such a grade of metal (cut - off grade) that can be used to utilize an economic gain, this part of the deposit is called a mineral resource and the mineralized material is called ore. The rest of the deposit, with lower content of metal grade, is considered non-economic and in mining terminology is called waste. The cut-off grade term is used in the mineral extracting industry to distinguish the mineralized material (ore) that can be used profitably from the rest (waste) that does not represent an economic interest when the mining deposit is estimated.

When talking about exploitation of mineral resources, different concepts are encountered between the wealthy landowner (the state) and the private companies working on their extraction. Mining companies orient the works to maximize profitability under mining activity. Assessing the mining costs and price of metals, the underground mining operations of high grade metal bodies (A. Khodayari, A. Jafarnejad, 2012) are oriented. This action leaves in the underground, parts of the mineralized material that has metal content smaller than the selected cut of grade. On the other hand, the state is interested in increasing the value of the mineral resource and through its organisms, exercising control and requires the extraction from the underground to the low grade ore reserves.

From the point of view of the public interest, dominates the opinion that the extraction and acquisition of mining assets, as a national non-recurring wealth, must be rationally realized. Even the mining from the underground to the poor one-source reserves starts with the conclusion of the contracts in determining the boundaries of the mine and lower taxes. Only like this the mining enterprises will be interested in extracting from the underground even the poor ores, while the state has realized the ultimate goal, rational acquisition of mining assets.

Mining activity studies set the value of a resource by the profit obtained in a mining activity. Mining companies can increase profits by utilizing mineral reserves of high content, which reduces costs in producing a tone of concentrate and shortens the life of the mine. Such action reduces the reserves of a mining source, thus decreasing its value (S. Lipo, N. Polo, 2018). When talking about increasing the performance in mining processes, it should not be enough just to control spending and improve the cost of preparatory mining works, drilling operations and mineral enrichment costs. Particular care must be taken in the realization of mineral extraction indicators and indicators of loss and dilution in the mineral extraction and enrichment process.

1. BRIEFLY ABOUT BREAK EVEN CUTOFF GRADE

The most important moment during the design of a mining activity is to define the boundary of the commercial component content, which separates mineralized material in ore and waste. So the key variable is the concentration, the minimal industrial grade of the metal in the mineralized material. Costs for extraction and processing of this material (ore) are recovered from the value that will be obtained from the sale of the produced product. In a broader definition, cut-off grade (Taylor, H.K. 1972), is any grade that is used to separate two courses of action, that is, to use or not extract from the underground, enriching it, or sending it to the dump of waste.

In the finished works in this field, the cut-off grade parameter depends by the value of melted ore (metal) and the costs for the production of this final product. To better understand the cut-off grade theory of concrete resource, we are giving in a simplified form, formulas for calculating the value of the ore and the cost for the production of the final product, so:

$$V = \bar{g} \cdot y \cdot P_m \quad (1)$$

$$C_T = C_M + C_P + C_{Sh} \quad (2)$$

Where:

V - Ore's value; $\bar{g}$ - the content of the metal in the ore; y - the recovery indicator in metallurgy; P_m - Price per a tone melted ore (metal); C_T - The total cost of producing the final product; C_M ; C_C ; C_{Sh} - respectively the costs for the extraction, enrichment and melting of ore

Depending on the formulas above, is calculated the minimum industrial content of the metal in the ore (break even cutoff grade) with the equation:

$$\bar{g} \cdot y \cdot P_m = C_M + C_P + C_{Sh} \quad \text{and we have} \quad g = \frac{C_M + C_C + C_{Sh}}{y \cdot P_m} \qquad (3)$$

The minimum industrial content (g) indicates the minimum level of metal content in the mineralized material, which causes the material to be considered as ore and can be utilized. But a mining activity works to secure a planned profit, depending on the level of investment and the risk of returning this investment. If we accept the planned profit rate (f), we can calculate the cut-off grade that will provide us with this profit, therefore:

$$g_f = f \cdot \frac{C_M + C_C + C_{Sh}}{y \cdot P_m} \qquad (4)$$

In the equation (4) only the price per one tone of molten ore does not depend on the technologies selected for extraction, enrichment and melting of the ore. The fluctuations of this parameter depend on the demand and supply for a given mineral. The impact of this parameter on the calculation of the average metal content in ore is important, therefore mining companies show caution in determining the expected price volatility of the final product sales price.

The other parameters relate to the technology selected in extraction, enrichment and melting of minerals and are determinants of the success of a mining activity. In this set of parameters, mining indicators are more difficult to achieve, while metal enrichment and melting parameters are more stable.

2. CUT – OFF GRADE AND THE VALUE OF A MINING RESOURCE

A mining activity consists of three distinct stages from each other and specifically from ore extraction (mining project), mineral enrichment activity, and melting activity and preparation of the final product (metal). Thus, a mining activity can be organized in three forms:

1- Mining with final product, **mineral**,
2- Mining + enrichment factory with final product, **concentration**, and
3- Mining + enrichment factory + metallurgy with final product, **metal**.

Most often in the mining practice we find the variant (2). In a few cases, a mining activity can only consist of mines, with the final extracted mineral product, as this form of work provides a small profit, compared to the calculated value per single source. The third variant would be the best variant and commonly applied, when powerful investors have a mining activity supported in ore deposits with considerable reserves.

The three stages of mining activity (mining, enrichment and smelting) are subject to production constraints and in all three stages, in order to maximize the profit that can be obtained from a ton of ore. If mining activity works under Scheme (2), the most usable scheme today in our mines, then the final product would be the concentrate produced after ore enrichment. In this case, the break-even cutoff grade and cut - off grade would be calculated with the equations:

$$g^c = \frac{C_M + C_C}{y' \cdot P_c} \quad (5) \qquad\qquad g_f^c = f' \cdot \frac{C_M + C_C}{y' \cdot P_c} \quad (6)$$

Where y' - recovery index in enrichment (%); P_C - the selling price of the concentrate, $/ton.

Equation (5) indicates that the minimum industrial content of the commercial component (metal) is the content in which the gross value of the ore extracted from mines and enriched is equal to the cost of mining and enrichment. This content is the limit of the metal degree below which the mineral reserves would not be utilized profitably. Equation (6) indicates that the content of the commercial component (metal) is the content that will be worked, with a pre-assessed profit (f ').

If we accept approximate values (each mining activity has its own specifics) of mining cost in underground mines (= $ 20 / ton), enrichment cost (= $ 15 / ton), recovery indicator (= 0.8%), the selling price of copper concentrate with an average content of 20% Cu. (= 1000 $ / ton) and the planned profit (f = 1.20), would have the following results:

$$g^c = \frac{25 + 15}{0.8 \cdot 1000} \approx 0.875 \text{ \% Cu} \qquad\qquad g_f^c = f \cdot g^c \approx 1.05 \text{ \% Cu}$$

The estimated value of the calculated minimum industrial content ($g^c \approx 0.875$ % Cu) indicates that in a given copper resource must be extracted from the underground and enriched, only those parts of mineralized material having a copper content of not less than 0.875% Cu. The other parts of the mineralized material reserves should be left in the underground, or extracted and stored in the waste dumbs. To get the planned profit of this mining activity, the mineral that goes in the process of enrichment must have a content not less than 1.05% Cu.

The two indicators estimated above are very high for their use in our copper mines. If we refer to the dependence reserve curves, and the average content of metal in this ore, (see Figure 1), build for an ore copper deposit in our country, we notice that the reserves curve on the cut - off grade falls rapidly with the increase in the cut - off grade value. By selecting the content of about 1.3% Cu (point "a" in the curve), the reserves of this resource will be halved and as a result, the value of this ore deposit will decrease significantly.

Selecting a small content as possible (0.5% Cu) would increase resource reserves (≈1,700,000 tons), and increase the value of the ore deposit. Working with such metal content in the ore should provide extra productive cost of a ton of concentrate and a high price of metal sales.

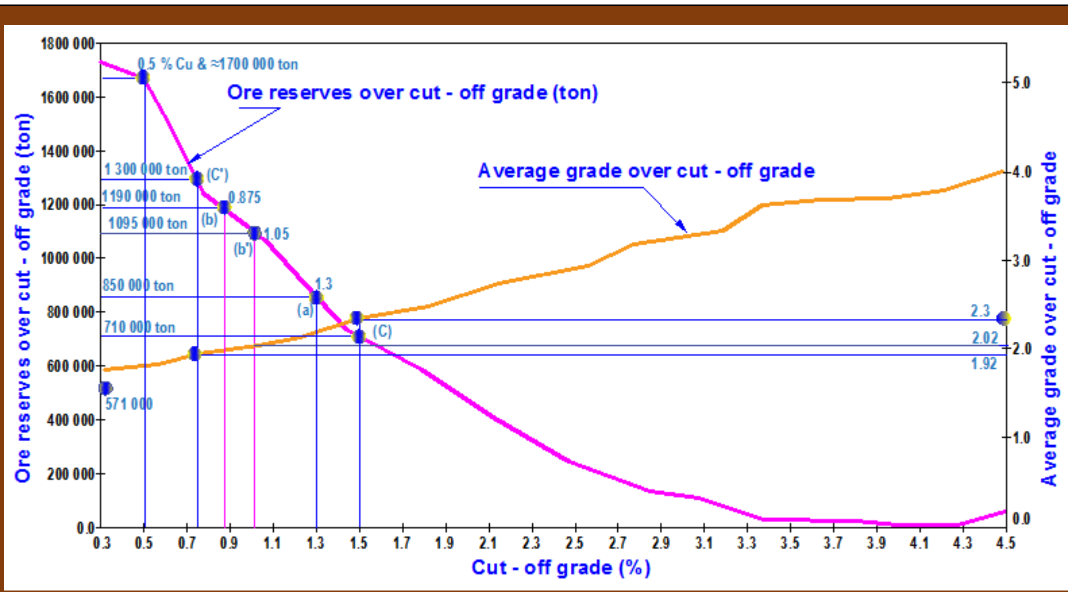


Figure 1 *Dependence of ore reserves and average metal content from cut – off grade*

The selling price of the product depends on the market demand and supply of a certain mineral. Although the trend of metal price fluctuations in the last 40 years has a steady growth trend, there is often a significant decline in the prices faced by difficulties in mining activities. As a result of metal price decreases in recent years, we have also closed some mines in our country.

The copper concentrate selling price, with average copper content (20% Cu), is characterized by large fluctuations. This price in the last 10 years has captured values from 700 to 1400 dollars per ton. If we were to put these values in the drawings (5 and 6), keeping the other variables unchanged, we would obtain the values of minimum of grade and cut-off grade of the metal in the ore:

For P_C = 700 $/ton we will have $g^c \approx 1.25$ % Cu and $g_f^c \approx 1.5$% Cu

For P_C = 1400 $/ton we will have $g^c \approx 0.625$ % Cu and $g_f^c \approx 0.75$% Cu

For a high price of concentrate, we have a relatively small value of the metal content in the ore, so there is an increase in mineral resource reserves. The opposite happens when the selling price of the concentrate is low. In this case from the mineralized reserves of material will only be treated as ores the ones that have higher content than 1.25% Cu, thus reducing the value of a mineral resource.

If the abovementioned sizes are reflected in the curves shown in Figure 1, we note that the drop in the selling price of the concentrate at the level of $ 700 / ton would increase the cut-off grades to 1.5% Cu. This increase in grade will reduce the reserves of the ore (point c) and from the source would be utilized about 710 000 tons of ore with $\bar{g} \approx$ 2.3 % Cu. And for a high price of the final product (in this case P_C = 1400 $/ton), thus for a ($g_f^c \approx 0.75$ Cu) cut-off grade, from the source would be utilized 1 575 000 tons of reserves (point c') with an average content of $\bar{g} =$ 1.86 %Cu. We accept unchanged metal mining and enrichment indicators, and we appreciate that in the first case, the amount of metal to be sold will be 1 633 000 tons, while in the second case 2 496 000 tons.

By comparing the amount of metal to be provided for, the difference of 863,000 tons of metal is definitive and we it not be neglected in the case of our copper mines, where the average amount of ore reserves fluctuates around one million tones. Note that even under the conditions of mining activities, working on deposits with considerable reserves, would not be acceptable to assessment as “waste” mineralized material with a grade metal 1.25 % Cu.

3. MANAGEMENT OF MINING PROCESSES, THE BASIS OF THE SUCCESS OF A MINING ACTIVITY

When talking about the main factors determining whether an ore deposit will be used for exploitation, first the reserves of ore and the grade of metal in these reserves are estimated, thus the amount of metal in the given source. These indicators are the only asset of an ore deposit.

When mineralized material in a source has high metal content, mining activity is generally profitable. The costs for extracting, enriching and smelting of mineral tones are decrease moderately, and the amount of final product (metal) obtained from the processing of each ton mineral increase.

Even the dimensions of mining deposit are very important. Undertaking a mining activity requires large spending and a long time to recover the expenses incurred. Not too small parts of the ore extract reserves, goes to cover these expenses. When the mining activity is supported in considerable reserves, the impact of capital spending on the success of a mining activity is signify-cantly reduced and work is organized to increase the present value through improved operating costs, cut-off grade growth, by extracting high content minerals, depending on metal price fluctuations.

When the ore reserves are limited the main requirement that comes to a mining activity is to extract ore reserves with as little quantitative loss as possible but also to control the quality losses (dilution of extracted mineral).

Quantitative and qualitative losses in the mineral mining process, with underground mining works, are inevi-table (S. Lipo; Kubaturat dhe rezervat, 2007). Their magnitude depends mainly on the utilization system used, the geology of the ore bodies, and size of the production units and their position in relation to the forms and dimensions of the ore bodies. Quantitative and qualitative losses are present in every production unit of mineral extraction, but appear larger in the production units located near the ore contours (Mechikov O.S. 2007).

The high quantitative losses in the underground mining process directly affect the reduction of extraction reserves of production and require the compensation of the missing production from other production units. Under the conditions where ore deposit reserves are limited, any lost tons of ore reserves will affect the economic balance of the mining activity. Even the quality loss control (dilution) is of particular concern. Dilution of mineral in the production process is associated with increased rock waste in extracted minerals. This brings negative impacts on the production of a ton of concentrate, the degradation of performance in the enrichment process, the growth of mining waste in the dumps of enrichment factories and the increase of negative impacts on the environment.

1.3 Interaction between indicators of mineral losses and dilution.

Losses and the dilution of minerals in the process of mining cannot be avoided. Their size and the ratio between the loss and dilution cannot be solved a priori. They are a function of the geological medium, the mining system, mining processes and the value of an extracted ore. In mining processes for extracting the ore, a combination of the above factors is achieved to provide low loss indicators and an optimal ratio between quantitative loss of the ore and dilution.

Generally, these indicators, especially in the systems of exploitation with block or sublevel caving, clearly affect one another, where the growth of the one indicator is accompanied by the decrease of the other indicator. The reducing of loss indicator, as the most significant indicator for the value of a manufacturing unit, in these mining systems, is mainly achieved by increasing the indicator of dilution. But even the dilution indicator cannot grow limitless, because not every increase in the dilution indicator will be accompanied by a decrease in the loss indicator.

If we refer to the dependence between the indicators of losses, dilution and the extracting ore indicator, built during the exploitation of a block with a block caving system and extracted the broken ore using the funnels, (S. Lipo, 1990), we would draw these conclusions (see figure 2):

In the process of collecting the broken ore, we distinguish two stages of extracting the ore.

The first phase consists, in the extraction of pure ore, starting the collection of the broken ore, until the moment of occurrence in the outlet of the dilution mass. During this phase, about 53% of the bloc reserves (point a) have been extracted for the block. Until now, the dilution mass has not reached the extraction outlet, while the loss rate is rapidly reduced to 47%.

The second phase begins with the manifestation of dilution mass in the extraction outlet. The dilution curve begins to grow slowly. With the continuation of the extraction of the ore together with the dilution mass, there is a rapid growth of the dilution curve, while the decrease of losses begins to slow down (point b). With the increase in the dilution indicator, there is a drop in metal grades in mineral doses and dilution in dose increases a lot. The interruption of the extraction at the Prrenjas mine occurred when the dilution in dose amounted to about 50%. After this point (point c), while dilution grew, the losses diminished very slowly. About 6% of the mineral remained as losses in every couple of funnels.

Although the magnitude of the indicators of mineral losses and dilution is determined by the mining and enrichment processes, the moment of break of the mineral extraction, thus the limitation of the dilution indicator, is related to economic indicators, and concretely the value of a ton of mineral and the cost of extracting and processing it. We note that the ratio between the loss indicator and the dilution indicator, especially for high value minerals, and mining activities that are supported in limited reserves should be as small as possible (Lipo S. Polo N. 2018).

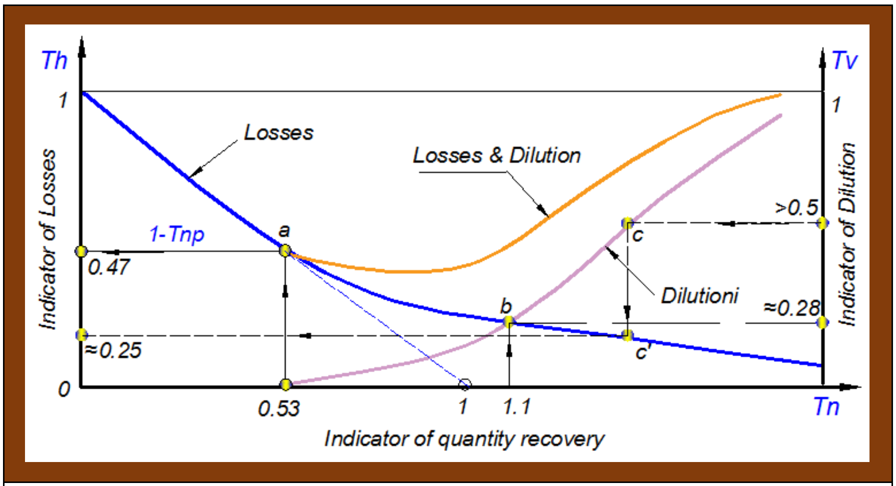


Figure 2 *Relation between mineral extraction indicators and losses and dilution during mining with block caving methods*

CONLUSIONS

The tendency of mining companies to work with a high value cut-off grade increases the profitability of a mining activity, but not the value of a resource. The public interest requires the increase of the value of the ore, thus the increase of the quantity of ore reserves to be allocated for acquisition.

The improvement of economic indica-tors in a mining activity relying on ore deposits with limited reserves should be sought and realized mainly in improving the indicators of loss and impoverish-hment, mineral extraction and enrich-ment processes. Through the careful management of the mining and enrich-ment, depending on the choice of ore of the selected exploitation system, should be worked with high indicators of extracting and the ratio between the indicators of loss and dilution must be as small as possible. Thus, will be extracted even the reserves of the ore with metal grades at the minimum industrial grade limits, so the value of the source will increase.

In block and sublevels mining methods, loss and dilution indicators have a functional relation, which cannot be avoided. In ore deposits with limited reserves, the target is to minimize the loss indicator even by increasing the dilution indicator. But the size of dilution indicator cannot increase much because it is limited by the value of a ton mineral, the cost of extracting it, the average metal content in the production unit reserves, and the cut-off grade size.

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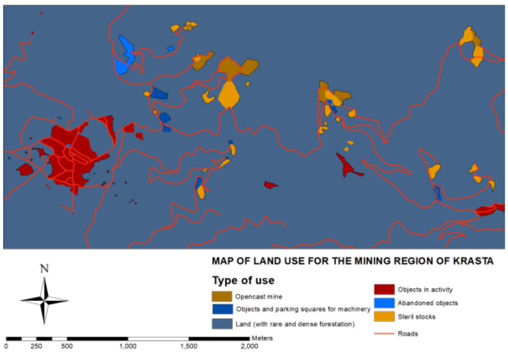
AUTHORS BIO

Prof. as. Dr. Skënder LIPO is a lecture in the Department of Mining Resources Engineering. Nowadays Prof. Lipo is chief of Department. With more than 35-year experience, Professor Lipo gives lecture in Master Diploma and School of Doctorates. He possesses good knowledge in 'Mining Measurement" and" Mining Subsidence Engineering" subjects. Professor Lipo has led 5 PhD students and many projects in the area of mining surveying, mining modelling and environmental protection

M.Sc. Nevina Polo is lecturer at the Energy Resources Department, Faculty of Geology and Mining, Tirana. She graduated as General Economist, from the Faculty of Economics, Tirana. In 2005, gained the Master of Science degree, in European Economic Studies, a master Diploma at the Faculty of Economics, Tirana, in cooperation with University of Bamberg, Germany. She has a 16 year experience as a lecturer in the following topics: Economics and Business Administration, Economics and Natural Resources Management, and Environmental Economics

M.Sc. Gezim Balla is a Mining Engineer at the Chromium Mine of Katjel. In 1992 He graduated as Mining Engineer from the Faculty of Geology and Mining. In 2015, he completed post-university education by defending the micro-thesis in the mining field. He has a 25-year experience as a mining engineer. He works in the mining field, giving a great deal of experience in the exploitation of chromium deposits with limited reserves. He has a continues cooperation with the Department of Mining Resource Engineering.



SOME MAPPING SPECIFICATIONS IN THE MINING REGION OF KRASTA

Msc. Ferit VRAPI[1]; Prof.as. Dr. Gafur MUKA[2]
Msc. Angjelina DERVISHAJ[3] Msc. Fation Kurti[4]

[1]Department of Applied Geology, Environment and Geo-informatics, Faculty Geology and Mine, Polytechnic University of Tirana, Rr. Elbasanit, Tirana, Albania.
E-Mail: ferit.vrapi@yahoo.com; Tel: +355 69 2702208
[2]Department of Mineral Resources
E-Mail: gafurmuka@gmail.com; Tel: +355 67 3388310
[3]Department of Applied Geology, Environment and Geo-informatics
E-Mail: angjelinadervishi@gmail.com; Tel: +355 69 9779654
[4]Department of Applied Geology, Environment and Geo-informatics
E-Mail: kurtifation@gmail.com; Tel: +355 68 4744682


Ferit VRAPI


Gafur MUKA


Angjelina DERVISHAJ


Fation KURTI

ABSTRACT

The mining region of Krasta is characterized by the presence of abandoned mining entities, reactivated mining entities which are used by concessionaires for the use of chrome reserves, granted by concession, by abandoned technological and socio-cultural object, as well as those newly reconstructed or constructed in function of usage permits. In addition to this, in this region are also the surface occupied by sterile stocks, chrome mineral stocks, urban surface and the natural terrain. The presence of all those objects "produces" a natural diversity in their use, so also in the land use. For the most effective management of this diversity it must be mapped the topography of these objects as well as the problems of their use.

In this paper are treated the features of creating and using maps that reflect the land use as well as the problems in using the special objects for the mining region of Krasta. In detail the attention is focused on building technology and database creation specifications based on the requirements for accuracy, clarity and completeness.

Key words: *mining region, abandoned mining entities, reactivated mining entities, sterile stocks, mineral stocks, natural terrain, technological objects, database, GIS*

1. INTRODUCTION

Mining regions include the entire territory where the mining activity takes place. This activity in our country, before the '90s, was administered by state-owned enterprises called "Mining Companies" or also known as "Mining". Under the conditions where the private property did not exist, the mining regions took place throughout the entire territory that they needed. For the extension of the mines, no expropriation were made and the boundaries were defined by the activity. In cases where the activity included residential areas, all existing buildings, or were put in use by the mine, or destroyed and the residents were moved somewhere else. To help with the mining activity and in order to accommodate the workforce needed for its accomplishment, new cities such as Bulqiza, Krasta, Memaliaj etc. were created. In addition to cities, other objects were built such as:

- Technological objects (mining works, minerals enrichment factories, well towers, sterile stocks etc.)
- Administrative objects, mainly office
- Social objects (refectory, bathroom, laundry etc).
- Residential objects (dormitory for workers)

In most cases the cities were built as a part of the mining region, while the above-mentioned objects were built within the mining region. After the 90s, when the mining activity was legally permitted for concession entrepreneurs, is also defined by law the surface of the mining region within which the entrepreneur is allowed to build technological, administrative, social and residential objects. Whereas before the '90s the rules for environmental protection were determined by the state, and the activity was carried out without environmental permit, after the 90s the entrepreneur is legally obliged to be equipment with environmental permit and to comply with all the obligations which are defined in it.

In this article, we will address the mapping specifications of the mining regions before the 1990s, while as a case study we chose the Krasta mining region.

2. PRESENTATION OF THE PROBLEM

Mapping is the entire process for creating maps [5]. The mapping specifics for the mining regions (mainly in terms of abandoned exploits [1]) are:

1. The features of the objects on the surface of the earth. Currently objects are determined based on the land use;
2. In the nature of the terrain where the objects are placed (relief);
3. In the placement and distribution of underground mining works;
4. In the technology used for mineral exploitation;
5. In the nature of the diffusion and impact of exploitation areas;
6. In forms of the appearance of the phenomenon of impact on the surface of the earth;
7. In the technology used to create the database.

In terms of development of mining activity, mapping produces [6,7]:

- Geological- Mine Surveying documentation, which documents the activity in the underground
- Land use documentation

- Risk map, which presents the degree of the harmful impact of underground exploitation
- The geo-risk map obtained by overlapping the risk map with the vulnerability map of the objects

Based on the specifications and products of mapping in the mining regions, we will address the mapping methodology in the mining region of Krasta.

3. MAPPING METHODOLOGY

Based on the products that mapping should produce in the mining regions, it is necessary to firstly consider the geological-mine surveying documentation and the mining technical exploitation documentation. In the geological-mine surveying documentation of mining regions are generally included: floor plans, vertical projections and profiles [7] while in technical-mining: passports of blasting, airing schemes, ways and pace of advancement of works, exploitation system etc., [4]. This documentation will be used for assessing the degree of risk of objects [3,8,9], indexing their vulnerability and building a geo-risk map [7]. Based on this map are outlined the areas of risk for objects.

After outlined the dangerous areas (Fig 1), and throwing them on the map of the region, we continue to create a map of land use. For its construction in the Krasta region, it was initially the identification of objects [10]. Identification highlighted the following types of objects: Opencast mine; Steril Stocks; Objects in activity; Formally abandoned but illegally used facilities eg. to store chromium collected from stocks (For this we do not have much information); Objects and parking squares for machinery; Abandoned Objects; Roads; Land (with rare and dense forestation).

For mapping these objects, were used orthophotos of the year 2015. Firstly, we digitized them and created the attribute table using ArcGIS 10.1 and then we visualized these objects (Fig 2 and Fig 3).

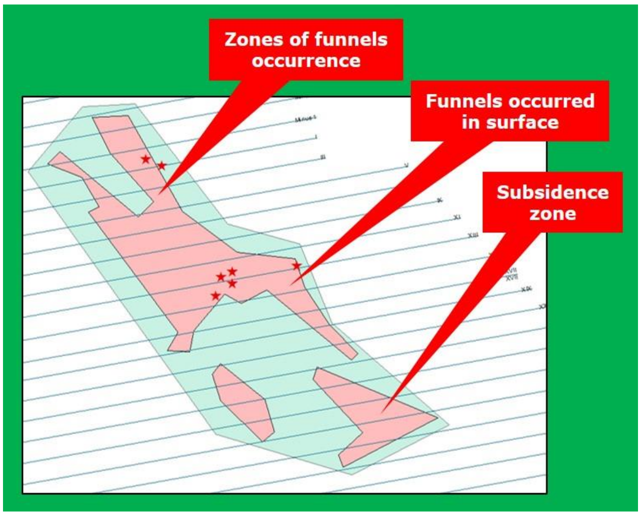
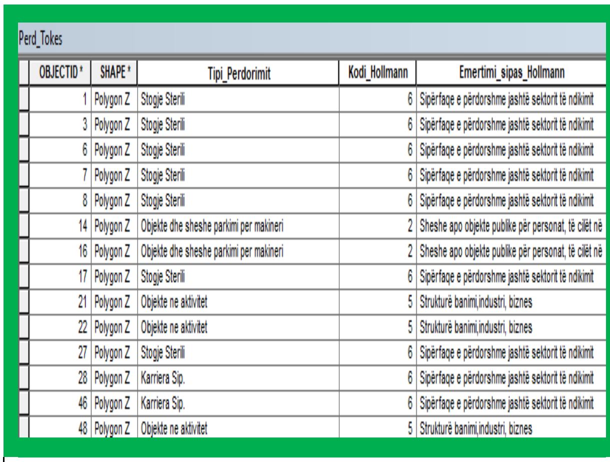


Figure 1. *Contouring of risk areas and occurrence of the impact of exploitation [7]*



Perd_Tokes

OBJECTID *	SHAPE *	Tipi_Perdorimit	Kodi_Hollmann	Emertimi_sipas_Hollmann
1	Polygon Z	Stogje Sterili	6	Sipërfaqe e përdorshme jashtë sektorit të ndikimit
3	Polygon Z	Stogje Sterili	6	Sipërfaqe e përdorshme jashtë sektorit të ndikimit
6	Polygon Z	Stogje Sterili	6	Sipërfaqe e përdorshme jashtë sektorit të ndikimit
7	Polygon Z	Stogje Sterili	6	Sipërfaqe e përdorshme jashtë sektorit të ndikimit
8	Polygon Z	Stogje Sterili	6	Sipërfaqe e përdorshme jashtë sektorit të ndikimit
14	Polygon Z	Objekte dhe sheshe parkimi per makineri	2	Sheshe apo objekte publike për personat, të cilët në
16	Polygon Z	Objekte dhe sheshe parkimi per makineri	2	Sheshe apo objekte publike për personat, të cilët në
17	Polygon Z	Stogje Sterili	6	Sipërfaqe e përdorshme jashtë sektorit të ndikimit
21	Polygon Z	Objekte ne aktivitet	5	Strukturë banimi,industri, biznes
22	Polygon Z	Objekte ne aktivitet	5	Strukturë banimi,industri, biznes
27	Polygon Z	Stogje Sterili	6	Sipërfaqe e përdorshme jashtë sektorit të ndikimit
28	Polygon Z	Karriera Sip.	6	Sipërfaqe e përdorshme jashtë sektorit të ndikimit
46	Polygon Z	Karriera Sip.	6	Sipërfaqe e përdorshme jashtë sektorit të ndikimit
48	Polygon Z	Objekte ne aktivitet	5	Strukturë banimi,industri, biznes

Figure 2 *Building the attribute table for land use*

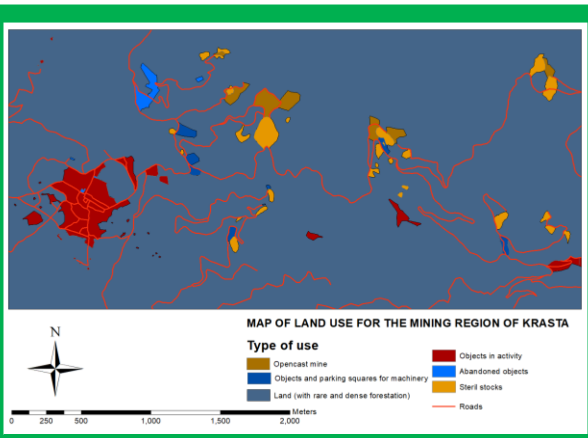


Figure 3 *Map of land use for the mining region of Krasta*

For presentation standardization, objects are classified according to Hollmann's scheme [2]. The following table shows the classification according to Hollmann for the identified objects in the mining region of Krasta:

Table 1 *Classification according to Hollmann*

Usage name according to us	Hollmann Code	Usage name according to Hollmann
Opencast mine	6	Area of use outside of the impact sector
Steril Stocks	6	Area of use outside of the impact sector
Objects in activity	5	Residential, Industrial and Business Structure
Formally abandoned but illegally used facilities eg. to store chromium collected from stocks (For this we do not have much information)	4	Residential structure, buildings
Objects and parking squares for machinery	2	Squares or public objects for persons who in the majority do not seek help or guidance to leave a dangerous situation
Abandoned Objects	4	Residential structure, buildings
Roads	3	Roads and public transport complexes
Natural land (with rare and dense forestation)	7	Agricultural, forestry and water surfaces

Figure 4 shows the presentation of the land use map of the Krasta region in Google Earth.

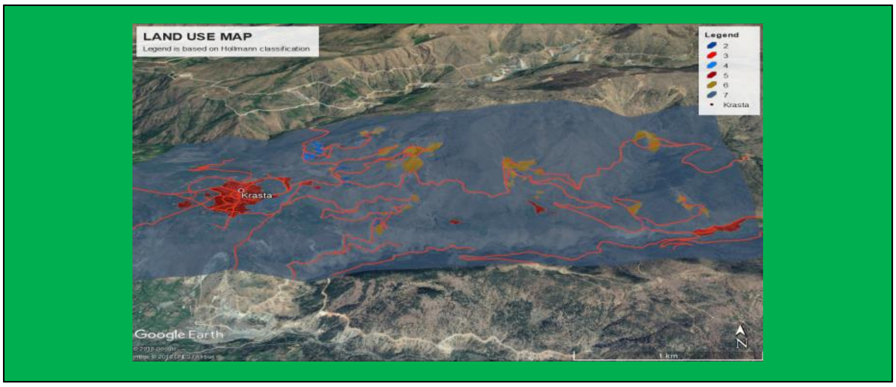


Figure 4 *Land use map in Google Earth. The legend is based on Hollmann classification*

Regarding the creation of data for the mining regions maps (for the vector format as well raster format) it should be said that today's technology creates the possibility for accurate, complete and comprehensible data. An important role is the dron technology through which data is obtained for all surface objects in the mining region. These data are created, processed, analyzed and visualized quickly, adding the value of use to the product. In addition, the use of drones also provides data updating opportunities, while administration, processing and visualization technology achieves fast production consistent with the needs of using maps. Regarding the data for creating risk maps, those of vulnerability of objects and geo-risks will be used the methodology recommended in the literature [7].

4. CONCLUSIONS

1. The mapping specifications in the mining regions relate to the nature of the impact of exploitation, the presence and vulnerability of objects in them as well as the land use planning.
2. Classification of objects in mining regions should be standardized. In the present case is accepted the Hollmann classification standard.
3. Construction of mining region maps taking into account the specifics of mapping helps in the thematic structuring of spatial data.
4. In the conditions of reactivation of exploitation, as it has happened in Krasta, the map of the mining region helps in design with a directed impact of abandoned exploitation. This is accomplished by carrying out a continuous monitoring of the impact within the region of influence and the immediate mapping of these results.
5. Mining regions maps help local government in designing urban, social and agricultural development activities away from the harmful impact of abandoned exploitation or taking it into consideration consideration by using of constructive-construction measures, etc.
6. Mining regions maps should serve as a basis for issuing mining permits, especially in terms of reactivated uses and in any case of environmental permits.

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AUTHORS BIO

Msc. Ferit VRAPI: Born on August 28, 1994 in Tirana. In 2016 has completed bachelor studies for Geoinformatics Engineering in Polytechnic University of Tirana, Faculty of Geology and Mining (FGM). He completed Master degree in Geoinformatics Engineering on 2018. His work experience includes: Teaching practice in Urban Planning Offices, Municipality of Kamëz, Teaching practice in the Cadastre offices, Municipality of Kamëz. Actually works in the Cadastre Office, Municipality of Tirana.

Prof.as.DR. Gafur MUKA: Received in 1978 the Master degree in Surveying Engineering, and in 1990 the PhD degree from Polytechnic University of Tirana, Faculty of Geology and Mining. For three years he worked as surveying engineer in Bulqiza chromite mine. He is trained in Montana universitaet, Loeben, Austria and in RWTH, Aachen Germany. From 1981, he is lecturer at the Faculty of Geology and Mining in Tirana, Albania, teaching "Mining Damages", "Geoinformation Systems, GIS" and "Digital Cartography".

Msc. Angjelina DERVISHAJ: Born on January 26, 1995 in Fier. In 2016 has completed bachelor studies for Geoinformatics Engineering in Polytechnic University of Tirana, Faculty of Geology and Mining (FGM). She completed Master degree in Geoinformatics Engineering on 2018. Her work experience includes: Teaching practice in Urban Planning Offices, Municipality of Kamëz, Teaching practice in the Cadastre offices, Municipality of Kamëz, Nova Design Furniture, procurement office . Actually works in the IT Office, Municipality of Tirana.

Msc. Fation KURTI: Born in Peshkopi, Diber, 1994. He completed Bachelor studies on 2016 and Master studies on 2018 at Polytechnic University of Tirana. His work experience includes: Surveying Engineer. GIS Specialist, Geophysical Survey etc. Actually works at the Gjeokonsult & CO Company.

THE NEED TO CREATE AN ATLAS OF ABANDONED MINES IN ALBANIA


Gafur MUKA


Thoma KORINI


Ramiz BALLA

Prof.as. Dr. Gafur MUKA[1]
Prof.Dr. Thoma KORINI[2]
Msc. Eng. Ramiz BALLA[3]

[1, 2] Faculty of Geology and Mining, Tirana, Albania; *E-mail: gafurmuka@gmail.com*
Faculty of Geology and Mining, Tirana, Albania; *E-mail: tkorini@gmail.com*
[3]National Agency of Natural Resources; Albania, ramizballa@yahoo.com

ABSTRACT

Abandoned mining exploitations are composed from sites where mining activities as exploration, opening, preparation and exploitation of minerals occurred but, for various reasons, acceptable mine closure and reclamation did not take place or was incomplete. Their existence must be documented in a precise, clear and complete way through the relevant geological-surveying and technical-mining documentation. This documentation must be arranged, included in abandoned exploitation files, archived and made available to interested parties. The final aim is to contribute to the remediation and the development of land use activities such as small-scale agriculture, forestry, hunting, construction of recreational areas etc. Another possible path may be the reactivation of mining exploitation. Principally, in terms of use, the need for a quick and informative access to this documentation arises. To do this, a very effective way is to create an atlas and the corresponding database for abandoned mining exploitations.

This paper discusses how to produce this atlas based on the inventory of old abandoned mining exploitations, how to update it, how to make it and the corresponding database easily accessible and finally how to use it efficiently.

Keywords*:* Atlas, abandoned mine, documentation, data, model, GIS, monitoring

1. INTRODUCTION

The problem of abandoned mining workings has been treated widely either in the international literature [1, 5, 6, 8] or in the domestic one [4, 10, 11, 12, 17]. Among the others, the goal has been and remains that:

- Have to be evidenced the abandoned mine exploitation (mining) workings in a way as much as possible full, accurate and understandable;
- Have to be regionalized the sectors of their impacts either in the under- and over-exploited or in the ground surface;
- Has to be assessed the risk degree of this impact and it has to be mapped;
- Have to be taken the necessary administrative, constructive and technical-mining measures for reduction or avoiding of mining damages.

To accomplish these objectives, firstly, has to be available all the geologic-mine-surveying and technical-mining documentation that presents the prospection-exploration, development and exploitation activity of the deposits. The deficiencies of this documentation create the problems that led directly to the endangering (hazard susceptibility) to the normal development of different activities and also to the people life's [10]. The non-availability of such documentation could not be recovered because it is impossible its full re-compilation. The documentation also dictates to the all other activities that are connected with the regionalization of the impact, risk assessment and also with the measures to be taken for avoidance or reduction of harmful impact [9]. In these conditions the work to be done in the direction of collection, systematization, assessment and utilization of this documentation takes a first-hand importance.

2. IN SHORT FOR ABANDONED MINING WORKINGS IN ALBANIA

The abandoned mining workings in Albania could be seen as resultant of below technological-administrative behaviours:

- The abandonment during the mine preservation (conservation) which is accomplished immediately after the extraction of mineral reserves with favourable geologic-mining conditions, meanwhile the other reserves with unfavourable geologic-mining conditions, are remained not-extracted in an expectancy state of technological improvements or of more favoured prices' trend [11];
- The thorough abandonment of mining workings after the 1990 years, when the political changes determined the development of economic activities in the frame of market economy [4,11];
- The abandonment in the conditions of declaration of remained minerals reserves as technological losses, for which has to be created the full documentation of mine closure and have to be taken all the measures for the calculation and control of post-mining (post exploitation) impacts.

For the first case, as mains reasons, could be presented as follows:

1. The mining works in the conditions of a relatively outdated technology (mainly for exploitation before the years of 1990);
2. The obligation to fulfil the production plans even in the conditions of technological discipline 'violation.

Meanwhile for the second case [12], could be mentioned as follows:

1. The loss of sales' market, after the so-called eastern market, where and when have been abrogated the clearing exchange contracts;
2. The impossibility for investments in the modern technology and techniques aiming the decreasing of ore extraction costs;
3. The unclear relationships of property, because the State as sole owner, has not been able to hold even the shares in the exploitation of underground wealth;
4. The impossibility for facing the exploitation expenditures as result of low efficiency in the manpower utilization and in the outdated (backward) technology.

For the third case the abandonment of mining workings is referred to the international standards. Due to the reason that in two first cases the abandonment has not been made in the normal declaring ways of exploitation process interruption, it is ascertained that were not followed the standard and legal procedures for its accomplishment, thus the impossibility of establishing (creation) of respective graphical drawings and technical-mining documentation. As consequence are remained not accomplished as follows [11]:

- Clear evidence of balance of mineral reserves exploitation;
- Accurate mapping of the situation of open cavities (voids) and mine exploitation workings;
- Technical and technological of mine opening up and development workings;
- The planning of measures for isolation of contact with open cavities (voids);
- The removal of recyclable materials as rails, mine cars, etc.;
- Systematization, fulfilment and summarized archiving of geologic, mine-surveying and technical-mining documentation, etc.

As it could be ascertained without any difficulty, in the abandoned mining workings in Albania, there are the following perspectives:

- Reactivating of the mine exploitation in the conditions of improvement of technology and ores prices trend for extracting of mineral reserves classified as technological losses;
- The final abandonment of mine exploitation aiming the fulfilment of above mentioned deficiencies.

In these conditions the creation of abandoned mining workings' atlas could be the step to be taken in the right direction, particularly for fulfilling of existing deficiencies connected with cartographic documentation.

3. PRESENTATION OF THE PROBLEM

For the abandoned mining workings in Albania, seeing only the geography of distribution of mine opening up mouths, entrances, collars, etc. (Figure 1), could be said that they have a wide distribution. Their availability is mainly confirmed by the physical presence of mine opening up workings, by mine development (preparation) workings (in some cases even of those of exploitation) and by the exploited unfilled voids (mined out cavities). Another form of existence of abandoned mining workings in our country is the presence of waste rocks' stockpiles, which are almost located in the all mouths, entrances of mine opening up workings. [4, 10].

In all forms of existence, they also impact in the rock environment around them but also in the ground surface, endangering so the activities that could be carried out in surface and also in the people life [11, 12, 13]. They also constitute an environmental load impacting in the flora, fauna, land utilization, etc. [4]. Seeing in this context, could be understandable the necessity to have a full and accurate information for them, in order that:

Firstly, has to be known the precise location and to be highlighted as clear as possible the problems raised from their presence.

Secondly, have to be taken the administrative, technical-mining and also constructive-building measures to reduce or to avoid their harmful impacts.

Thirdly, have to be compiled the real and long-term plans to assure a utilization as much as efficient of the land, taking into consideration the impact.

Fourthly, has to be organized a persistent and qualitative monitoring of the impact process development in time, to keep it under control and to increase the efficiency of protective measures.

According to the peculiarities of the abandoned mining workings, the main role for information plays the geologic-mine-surveying and technical-mining documentation. In this frame, the creation of an atlas for abandoned mining workings could contribute in the thematic systematization of documentation, fulfilling its inventory, fast access in the information referring to the concrete problematic, sensibly increasing the quality of its solution, etc. Precisely, the importance of the documentation for atlas creation brings to the necessity of a more detailed investigation of it.

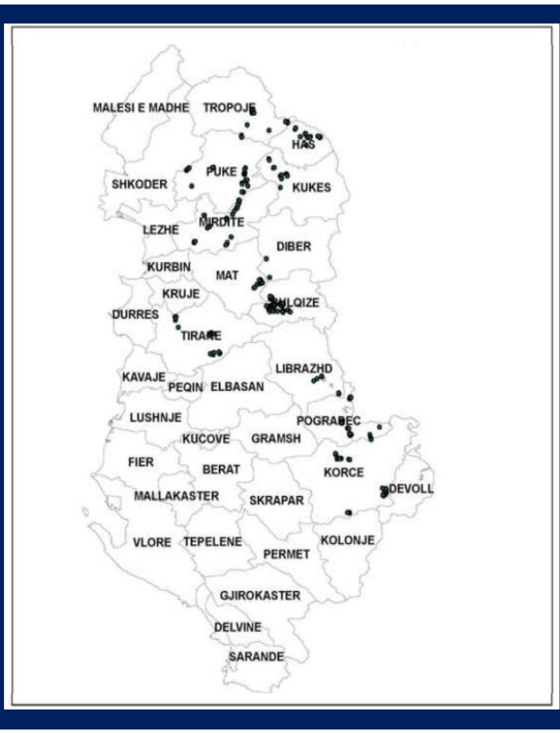

Figure 1 *Map of abandoned mine workings' entrances in Albania*

FID	Miniera administruese	MINERALI	Punimi
0	Mushqeta	Qymyr	Traverbark
11	Drenove	Qymyr	Traverbark
67	Gorë	Qymyr	Traverbark
104	Babien	Qymyr	Traverbark
107	Krosnisht	Qymyr	Traverbark
114	Qencke	Qymyr	Traverbark
122	Alarup	Qymyr	Pus
123	Pretushë	Qymyr	Traverbark
129	Dardhas	Qymyr	Traverbark
149	Verdove	Qymyr	Traverbark
152	Podgozhan	Qymyr	Traverbark
221	Valias	Qymyr	Pus
227	Mëzes	Qymyr	Traverbark
281	Krrabë	Qymyr	Traverbark
158	Kabash	Baker	Galeri
165	Kçire	Baker	Galeri
166	Paluc	Baker	Galeri
172	Shmeri	Baker	Traverbark
185	Poravë	Baker	Galeri
186	Tuç	Baker	Galeri
193	Qafe Bari	Baker	Traverbark
195	Munellë	Baker	Traverbark
199	Golaj,Has	Baker	Traverbark
284	Bulqizë	Krom	Galeri
285	Bulqizë	Krom	Galeri
286	Bulqizë	Krom	Galeri
347	Batër	Krom	Traverbark
504	Katjel	Krom	Traverbark
522	Bulqizë	Krom	Pus
523	Bulqizë	Krom	Pus

Figure 2
View of priorities list

During this investigation, results that will be raised the problems either with systematization or with its fullness. Special studies [10] have shown that are also problems with accuracy. This is the reason that initially has to be done the inventory of abandoned mining workings. The criteria to be followed to accomplish this task are given in the literature [18]. Among others, they include as follows:

- The compilation of the priorities' list for taking into consideration the enterprise that has administered the documentation, the sort of mineral and the denomination of mine opening up workings, creating so, an evidence list for administering enterprise, the exploited mineral (ore) from this mine and all the mouths, entrances of mine workings (drifts, etc.). This list has to be presented in the form of a table in Excel, with the columns as in Figure 2;
- The creation of documentation files where, based in the priorities' list created, have to be included the mine plans (layouts);
- The creation of geo-data for all listed mine workings (coordinates of entrances of mine workings and the geometry of their positioning);
- The structuring (building) of attributes' table where along with the denomination and the geometry, have also to be included the quantitative and qualitative indexes as, mine workings' length, amount of production extracted from the mine working, type of support, water flow, the presence or lack of equipment's of mine working as, rails, trolley, ventilation pipes, etc.;
- Listing of mine exploitation workings and their documentation in the working maps (mine plans), profiles and vertical projections;
- The creation of documentation files of mining regions maps, taking into consideration the administrative unit (mining enterprise);
- Updating of maps with the changes in the situation, relief and with exploitation impacts.

After the inventory work has directly to be initiated with the creation of atlas. Referring to the literature [2], an atlas is an entirety of maps which are mainly connected between them by the content and the regionalization. As a rule, the maps are presented at the same scale. The atlas is composed from three parts [2]:

- Introduction;
- Maps;
- Annex.

In the case proposed, to the introduction part, is thought to be included as follows:

- Overall data on development of mining industry in Albania;
- The characteristics of abandoned mine exploitation workings;
- The abandoned mine exploitation workings and those reactivated;
- Environmental impact of abandoned mining workings;
- The measures taken for avoiding, respectively reducing of mine exploitation damages;
- Actual situation and the perspective of abandoned mine exploitation (mining) workings' monitoring.

The maps constitute the main part of atlas. Regarding the content, in the maps of this atlas-book will be presented the problematic of the abandoned mine exploitation (mining) workings. For the purpose of determining the medium of presentation can be evaluated that the best medium form could be the electronic one while, that in hard copy could be used based on the concrete requests (printed on demand). The presentation in the electronic medium creates almost an unlimited space regarding the presentation scale. Taking into consideration that the surface area of mining regions in the boundaries of administrative unit doesn't surpass 5-6 km^2, that for the format A4, it is converted in a presentation scale not greater than 1:10 000, and also in the smaller scale of existing documentation of 1:2000, then it is evaluated from us that the geodata for the digital model have to be created for the scales not greater than 1:2000.

Referring to thematic, for every mining region, the maps have to contain the layering as follows here below:

- Maps of mouths, entrances, collars of mine workings (Figure 3);
- Maps of mine opening up workings (drifts, shafts, slopes, ramps, etc.) with respective geological and geotechnical factors;
- Maps of mine preparation-development and exploitation workings with respective geological and geotechnical factors;
- Maps of exploitation voids (spaces, cavities);
- The map of mining region' surface area and impacts occurred from mine exploitation (Figure 4);
- The map of hazard susceptibility (endangering) (Figure 5);
- The map of geo-risk (Figure 6).

For ranking of maps we could evaluate that has also to be taken into consideration the sort of mineral into the classifications: metalliferous mines (chrome, copper, iron-nickel), coal mines, other mines (rock salt, gypsum, asbestos, bauxites, etc.). In the Annex part we could evaluate that have to be included: The scanned documents, tables of data, and photos of impacted zones, respectively of impacted objects.

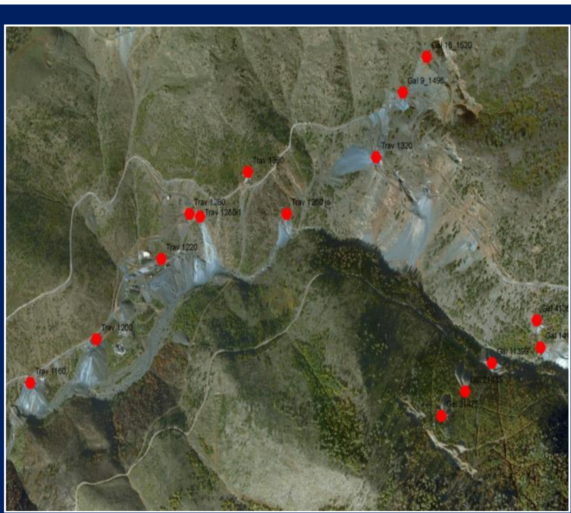

Figure 3
Map of mine workings' entrances

Figure 4 *Map of underground mining influence (funnels occurred*

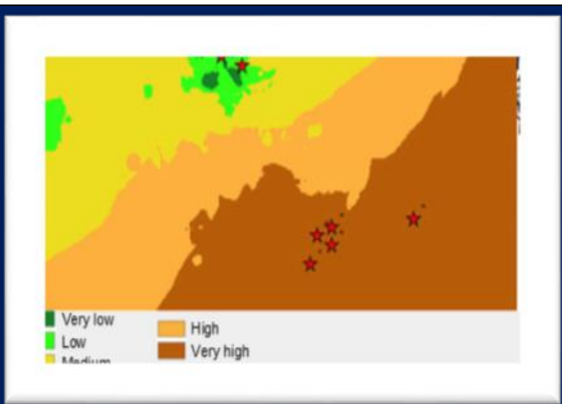

Figure 5 *Map of endangered zone and sinkholes occurrence [11]*

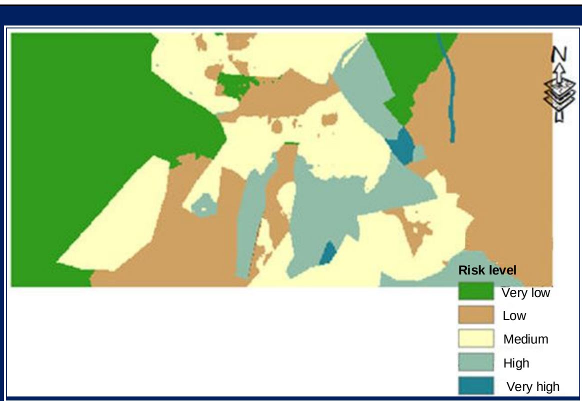

Figure 6
Map of georisk [11]

4. THE METHODOLOGY OF ATLAS COMPILATION

The compilation of atlas will pass in the following phases:

- The collection of Geodata;
- The Geodata administering;
- The analysis and assessment;
- The visualization.

In all these phases the treatment will be made based on the solutions offered by the program ArcGIS 10.xx. [3, 4, 7, 11, 14, 16]. The collection of geodata starts from the inventory process. In this phase are compiled the lists containing: the denominations of mines, sort of mineral (ore) and the coordinates of mouths, entrances, collars of mine opening up workings. Besides these, in the tables of attributes could be also added other attributes that are connected geographically with the Shape (coordinates of mouths, entrances, collars), and they are given by quantitative and qualitative variables as: the production extracted from the mine working, type of support, level of stability, water flow level, access possibility, etc. All these matters have to be systematized in the tables in Excel, which afterwards are imported in the environment of the programs ArcGIS as tables dBASE.

The continuation of data collection process, respectively of geodata is made through the digitalization in the applications of programs ArcGIS, passing in the processes of geo-referencing of the images, and afterwards to the creation of respective file-cabinets for their memorizing. Even in this case the fulfilling of the tables is done in Excel and after is passed in ArcGIS.

After data collection, it is done their administering process in the module mediums ArcCatalog. Taking into consideration the character of geodata and their geographical reference, it is selected as filing-cabinet "File Geodatabase", in which the memorization is done in the filing-cabinets. Referring to the character of data and their administering, from these filing-cabinets is selected the "Feature dataset". In this filing-cabinet are memorized subfile-cabinets "Feature Class" where is given the possibility to be memorized further on all the types of geometry (point, line, polygon) with the same space reference. Due to the reason that in our data are also included the images and tables, which are specific for every mine then, for a more appropriate administering, the memorizing filing-cabinets "File Geodatabase", are denominated specific for every mine, meanwhile that the classification as mines' group, for example, chrome, copper, coal, etc., is organized creating the folders containing the respective filing-cabinets "File Geodatabase".

The process of analysis and assessment (evaluation) mainly includes the fulfilments and controls connected with the data accuracy and credibility. This process is carried out in the mediums of module ArcGIS activating according to the needs, the respective applications as "Editor", etc.

The compilation of the atlas will be finalized through the visualization of the data according to the thematic planes. In this process are structured the layouts for every map. The products are memorized in the filing-cabinets. mxd in the medium of folders of group-mines.

5. CONCLUSIONS

1. The creation of an atlas of abandoned mining workings contributes for a better management of the problems raised from harmful impacts of these mine exploitation workings.
2. This atlas will increase the access velocity to the information, connected directly with the problem, of which solution is requested for each case.
3. Through the atlas of abandoned mine exploitation workings is realized a standardized systematization of existing documentation, are evidenced eventual deficiencies and are requested solution ways using the modern technology advantages, as in concrete case of technology GIS.
4. The existence of this atlas in the electronic format enables its fast updating, including the new data in the respective filing-cabinets.
5. The offered data from the atlas of abandoned mining exploitations help in the design of mine workings and in the planning of activities in the conditions of reactivating of abandoned mining workings.
6. This product sensibly impacts in the efficiency increment of land use planning in the mining regions.

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AUTHORS BIO

Prof.as. DR. Gafur MUKA: received in 1978 the Master degree in Surveying Engineering and in 1990 the PhD degree from Polytechnic University of Tirana, Faculty of Geology and Mining. For three years he worked as surveying engineer in Bulqiza chromite mine. He is trained in Montan universitaet, Loeben, Austria and in RWTH, Aachen Germany. From 1981, he is lecturer at the Faculty of Geology and Mining in Tirana, Albania, teaching "Mining Damages", "Geoinformation Systems, GIS" and "Digital Cartography".

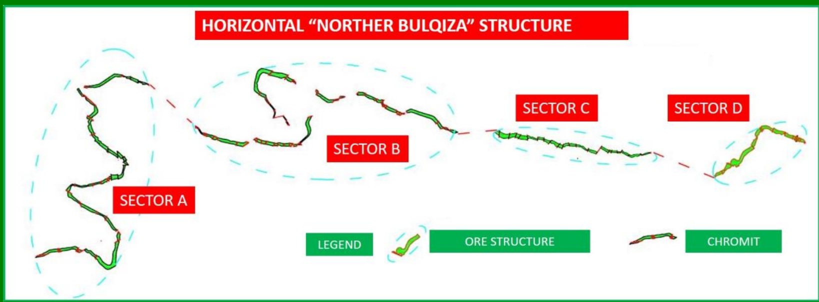
Prof.Dr. Thoma KORINI: received in 1981 the Master degree in Mining Engineering from Polytechnic University of Tirana, Faculty of Geology and Mining and in 1988 the PhD degree from Paris School of Mines. From 1982, he is lecturer at the Faculty of Geology and Mining in Tirana, Albania, teaching "Rock Mechanics", "Geostatistics" and "Computer Applications in Mining".

Msc. Ramiz Balla: received in 1987 the Master degree in Mining Engineering from Polytechnic University of Tirana, Faculty of Geology and Mining. He is Head of Sector of Procedures, Statistics, Financial Guarantees, Coordination and GIS, at the Albanian National Natural Resources Agency.

A NEW INSIGHT OF THE CHROMIUM STRUCTURE "NORTHERN BULQIZA" BASED ON THE MINE DATA

Dr. Martin CUKALLA

Tel: +355682033209
Email address:
mcukalla@yahoo.com



ABSTRACT

Northern Bulqiza is the northwest continuity of Bulqiza-Batter's chromium structure. In the vertical projection of the entire ore body, this section with approximate cross-section appears in the north part. The vertical projection has overlaid the wings of the fault and gives the impression of bending of the ore source also in the north-south direction with a diving northwest. Crosscutting is a wrinkle with some wings with some eastern elevation and where wrinkles develop from east to west. Data obtained from mining works to date have served the accuracy of the above-mentioned view.

This paper aims to provide a clearer representation of the Bulqiza North Zone's chromium structure according to the state of the mining works at each level, and to encourage a discussion for the structure itself. With this objective, all the plans were drawn with a scale 1: 500 from gallery 35 of level 16. In verticality there is a panel over 1000m from about 1500m where Bulqiza mine has been erected so far. Horizontally, the developments recognized by L_{II} *(so called east part 2) in* P_{IV} *(so called west part 4) are included in the scope. The introductions here are the documented state of the chrome ore body in the mining works carried out in this area at each level. Cuttings of the levels were laid on a joint plan on which the vertical and transverse structure projections were constructed.*

These elaborations led to the formulation of a structure model of the "Northern Zone of Bulqiza", which gives some insight into the imagination and that require clarifications. Note that Bulqiza ore source is a wrinkled structure in the cross-alignment direction. In the studied area of the structure there is no evidence of wrinkles according to what is called the extension of the ore body. While it is clear that the fold is present in chromium ore body, there is no sign of folded area in the surrounded peridotite rocks. In this part of the ore body changes the layout of the structure, so current profiles have noticeable deformations. In the analysis of the physical phenomena of the structure, also here we stand by the thought of its formation in an underground room. To understand the physical phenomena (fold, tectonics, etc.) the state as we see it was analyzed: the ore body in the gallery. Analysis of structure deformations in the horizons sought to avoid the effects of tectonics and folded on it. On this basis, some conclusions were drawn about the dynamics of kinetics and the diapiritic nature of the structure. The study concludes with conclusions and recommendations that can serve the field specialists and decision-makers in the future.

1. INTRODUCTION

The real data obtained from the exploitation works at the Bulqiza mine have continuously corrected the geological parameters of the chromium structure of Bulqiza orebody. For at least 30 years, this experience has been interrupted, causing repeated failures in prospecting-exploration works, wrong geological interpretations for Bulqiza / Batter's chromium structure, and lack of thought on the physics of the genesis of the ore body.

To fill this gap and to correct even my thoughts as an engineer for exploitation for this important mining facility, which is undergoing a crisis in discovering new chrome reserves and showing visible signs of extinguishing the mining object, I undertook this look on the data that the mining works offer us.

Official geological opinion is expressed. "Bulqizë-Batër is the largest source of chromium in our country. It has a stretch and continuous lying from NW - SE in a length of 5000 m and a drop of 500-1200 m. It has chromium body thickness from 0.50 to 5-10 m. Mineralization is related to the harzburgite-dunite sequence and is considered an integral part of Bulqize-Batra anticline structure.

The structure is slightly offset towards the northeast and has a southwestern decline. Its eastern wing falls at an angle of 70 ° to 80 °, while the west wing is 20 ° -30 °.
Chromite mineralization has met on both sides of this anticline structure, while in the southern areas of Bulqiza and Batra; it only meets on the western side.

The mineral body reveals a complex structural and morphological construction. It is represented by some mineralized wings, which are interconnected between them by syncline and anticline bending." (Group of authors, 2010: Monograph" Mineral resources of Albania ", p.46).

Here I do not intend to disrupt this opinion, I intend to give a full description of what appears in the works of exploitation, and perhaps also to submit a reason for some Why? Physics processes that turned the molten rock mass into the chrome body, as we find it drawn on planes of mining works. Naturally, to review all Bulqiza mine data, mining workings data, it would be impossible and difficult to provide the necessary data at the same time. The Zone "Northern Bulqiza-Bulqiza Veriore" was chosen even, because I think it is tectonically, as I envision this term, quieter than the other areas of the Bulqiza ore body.

2. METHODOLOGY

The aim is to create a real model of the chrome body of the "Northern Bulqiza-Bulqiza Veriore" Zone, built on the basis of the data of mining workings reflected in the hard copy plans of Bulqiza mine. The term used here is that of the jargon of Bulqiza mines. To clarify is that: The term "chrome body structure" is used to give the continuity in hard copy plans, i.e. into X and Y coordinates of chromium blocks according to alignment and to tectonic bonds. The term "chromatic structure of the Zone” also includes the "chrome body structure" and the rock mass surrounding it and which has directly influenced the shaping of the chrome body structure. For the compilation of the report were used hard copy plans of mines in a scale: 1: 500, maps of the plans of mine levels in scale 1: 1000 and the geological profiles of Bulqiza ore body.

The Geological Map of Ultrabasic Massive of Bulqiza in a scale 1: 25000 is used to clarify restrictive tectonics in the east and west of the v. of Bulqiza. The plan boundaries of the Zone under consideration were assigned to the common floor plan. The Dipping of the Zone was determined according to the vertical projection of the chrome body structure. The falling (decline) of the Zone was determined by the construction of the chromitic cross-sectional projection. On the basis of the mining plans, descriptions have also been made that clarify the phenomena that have deflated the structure of the chrome body. The answer to "Why?" Was based on treatments for the geodynamic evolution of the chrome body structure. Changing of Rock mass and their influences are evaluated from the point of view of their physics and not geological aspects.

3. CHROME BODY STRUCTURE IN THE "NORTHERN BULQIZA" ZONE

In the common plan, (Fig.1), it is seen that the chromium body develops from northwest to southeast in some structural forms. The northernmost part of the upper levels (GALLERY 35-LEVEL 4) is a multilevel plane with two synclines and two anticlines developing from west to east. The western wing of this wrinkle walks northwest and closes sometimes tectonically, times, genetically. The eastern side of this wrinkle walks to the southeast and is generally tectonically interrupted.

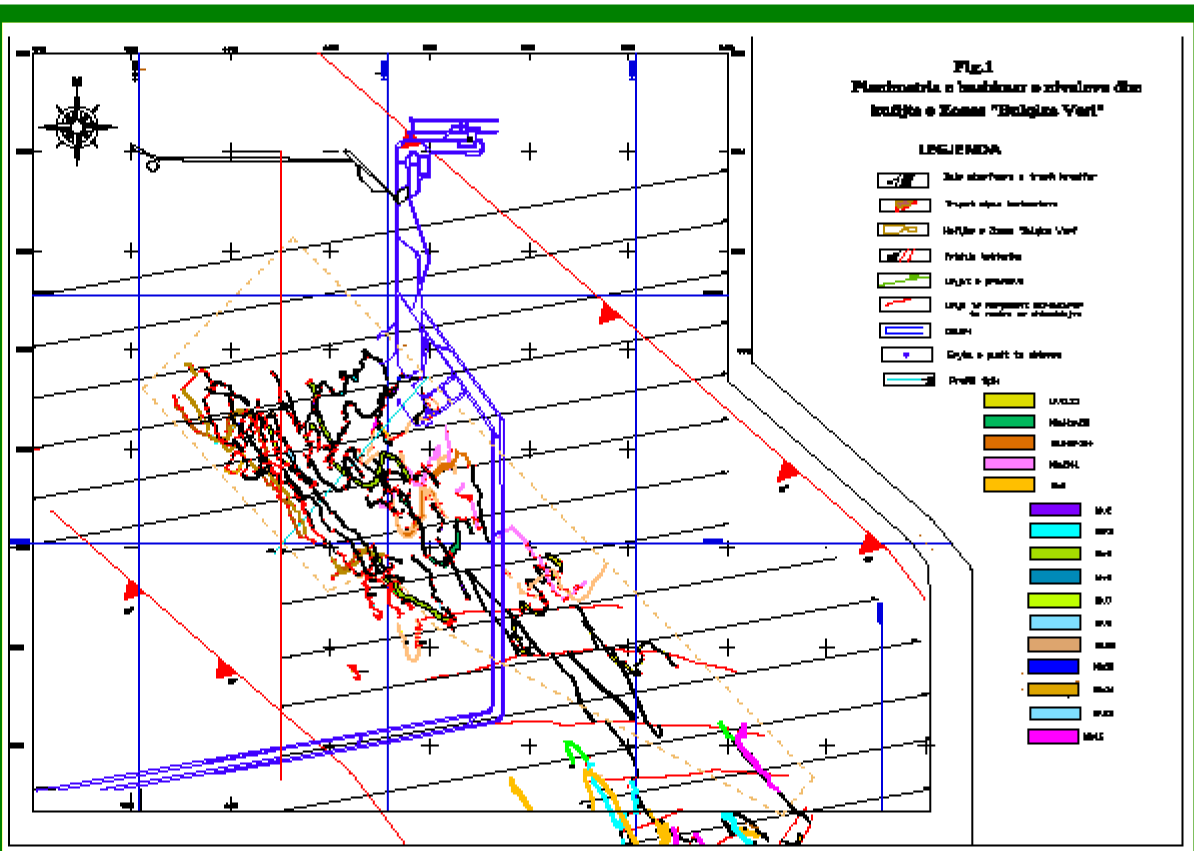


Figure 2 *The chrome body plan for the "Bulqiza Veriore" Zone*

Behind this first wrinkle, to the southeast, at 50-150m distances, develops the second wrinkle, which appears on regular forms on several levels (GALLERY.35, LEVELS.5, 6, 12, 13.1 4, 15, 16) and tectonically damaged in many others (HORIZON.104, GALLERY.41, level 8, level 9). This wrinkle has a syncline and an anticline. The western wing of the syncline walks toward the north and connects to the eastern wing of the first wrinkle. The eastern wing of the anticline walks to the southeast and is linked to the monoclinic development of the ore body. The connection is sometime tectonically, sometimes of normal continuity, and sometimes of detachment. Further to the south of the second wrinkle begins a monoclinal development of the chrome body structure. This development follows for 200-250m uninterrupted, with slight shrinkage of lying and falling from level to level, but does not appear at levels GALLERY.35, levels10, 11. The body thickness in this part of the Zone is smaller than in other parts. The development of the chrome body structure closes to the southeast with a short nonclinical sequence, with a duplication of this part or with a sloping bush (elbow), which goes in the west.

4. CHROME BODY PLAN MODEL

Based on these statements was constructed the model of the chrome body plan for the "Northern Bulqiza" Zone. As outlined in Figure 2, the design template structure includes four sectors named here: A; B; C; D. Of course, here are evaluated the developments in the X and Y-axes of the chrome body structure. Table 1 gives comparative Model data with each level plan for the presence of sectors across levels and the correlation between sectors.

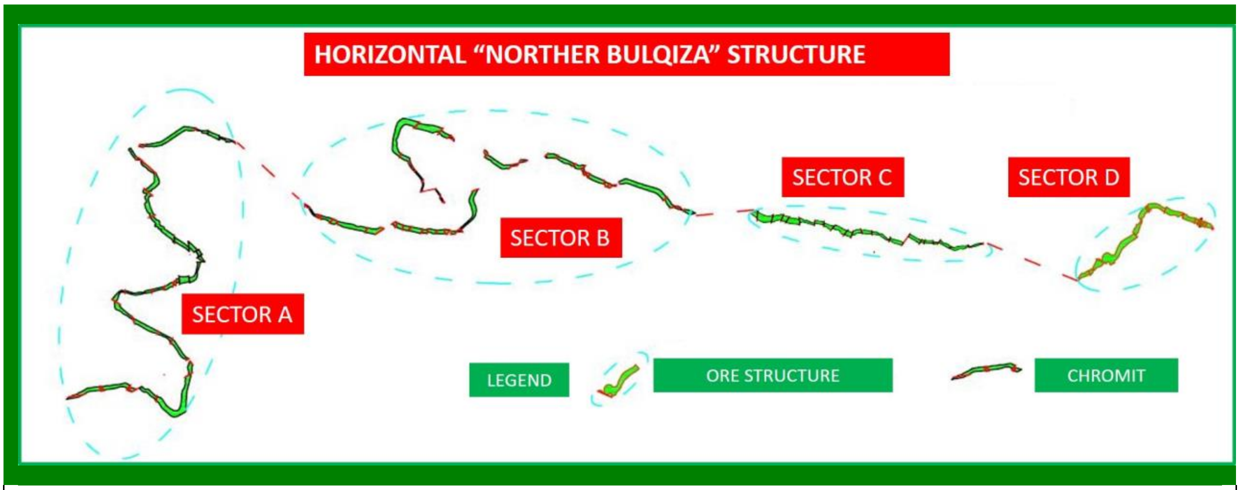


Figure 2 *Plan Model for the chrome ore body for the "Northern Bulqiza" Zone*

This presentation highlights insignificance and similarities. Based on the similarities, to evaluate developments along the Z-axis, four panels are grouped:

(a) The Gallery 41-Gallery 35 level panel:

Here we have the upper and eastern part of the structure of the "Northern Bulqiza" Zone. Without questioning the full disclosure and utilization of the structure, we can provide reasonable explanations for each level. The floor level of decline of Gallery 41 has fragments of the linear extension of the structure and any excessively distributed part of the wrinkle system. At gallery 41, the structure appears with the southern parts of the northern wrinkle, with the linear part branched and the second wrinkle which is tectonically shifted by the alignment axis. The southeastern linear part of the structure ends with a nearly rectangular eastern curve and is closed tectonically there. At horizon 104 of Pit 1, the structure is presented with considerable thickness, perhaps the largest in the ore body, a full three wings wrinkle with a linear elongation above 200m, which connects the two wings opposite wrinkles. The chromium body closes with eastern growth after the last wrinkle turn.

Table 1 *Data on the structure of the chrome body by the levels*

Level	Appears Sector				Situation of connection			Note
	A	B	C	D	A-B	B-C	C-D	-
Gallery 35					HJT	-	-	-
Horizon 104					HJT	-	-	B separate
Gallery 41					HJT	-	-	B double
Decline Gallery 41					HJT	-	-	B double
Level 1					HT	HT	-	-
Level 2					HJT	HJT	V	-
Level 3					HJTK	HT	V	D double
Decline Level 3					HTK	HT	V	A double
Level 4					HJT	HJT	V	-
Level 5					-	HT	-	-
Level 6					-	HT	-	B less developed
Level 7					-	-	-	-
Level 6					-	-	-	-
Level 9					-	-	-	-
Level 10					-	-	-	-
Level 11					-	-	-	-
Level 12					-	HJT	V	D double
Level 13					-	HJT	HT	-
Level 14					-	HJT	HT	-
Level 15					-	HT	HJT	-
Level 16					-	HJT	HJT	Less touched

Note: *Nontectonic OPENS-HJT; Tectonic OPENS –HT; Tectonic; OPENS with holding chromium body- HTK; Nontectonic OPENS with holding chromium body- HJTK Continuity -V*

(b) Level 4-1 Panels

In this part of the structure we have developments of the two wrinkled sectors. It begins in the north with the appearance of a big wrinkle with more than 5 wings. The wing to the northwest does not develop. The southeast wing walks linearly over 200m and further forms a new, three-fold wrinkle, similar to the wrinkles observed in other over-analyzed panels. Further, in the southeast, even over 300m of the chromium structure the tectonic developments in the chrome body structure of these levels have failed to disrupt the similarities that characterize as a group. The first wrinkle system, the second wrinkle system, and the further lineage in the southeast are present in the 5 levels of this group. The southeast development of the structure is present in all five levels, while northwest development is not complete at level 4, which is reveals special structural feature. The second wrinkle system is not so clear at Level. 4 and at the dysentery, the full representation is in the three upper levels (3,2,1) with that similarity of appearance that this phenomenon also has on levels 16-12.

(c) Panel Levels 11-5

This panel shows a fierce interference of the tectonic development which causes the loss of unbound linear development on the northeastern side, the loss of three-fold wrinkles, and at levels 11 and 10, it appears only the end curves as an elbow to the east. In the above levels (9-7) only wrinkles appear, much touched by tectonic developments. At levels 6-5, the B-wrinkle appears to be more complete and there is some development of its linear part in the northwest and southeast. With the rise in the quota, an increase of the western walking step is anticipated with at least 10%.

(d) Level 16-12 Panels

The structure that is reflected in the level 16 plan is less deformed. The 16th level stretches from the northwest to the southeast with the 138 ° on a square with a width of 106m and a length of 520m. If we compare the wrinkle at level 16 levels with those of level 5, we notice little changes. The eastern edge of the Level 5 wrinkle is almost the same as the bow of the western wing of the Level 16 wrinkle. The western edge of the 5th level wrinkle has an eastward printing and a somewhat more developed linearity, while the eastern edge of the eastern wrinkle has some kind of bounce in this direction, less damaged by tectonic developments and a thicker ore body. Rising from Level.16 to Level.12 there is an increase in the rate of influence of tectonic developments.

5. DESTRUCTION, DESIGN AND STRUCTURE DEFENSE

To extract this data, it is impossible to rely on the structure of the chrome body but on the chromitic structure of the zone. To reach the chromitic structure of the Zone, one should evaluate the tectonic system surrounding it. In the absence of the recognition of a specific material on this issue or of direct observations on the ground, the data of the Geological Map of Bulqiza Ultrabasic Massive, is scale 1: 25000 are used. On the map are given two tectonic plans with AZ = 315°, extending to, the first on the eastern side of the Northern Bulqiza Zone with Western Decline 75°, and the other on the west side with western declining 65°. The horizontal distance of these two planes is about 1000m. These data are fixed at 1800m quotes. To the north, somewhere in the 950m quota is fixed the western decline of these tectonic developments, 65° (both east and west), and the distance between them about 800m.

Though controversial, here is accepted this tectonic system that limits the chromite structure of the "Bulqiza Veriore" Zone in the east and west. The Azimuth of lying of the "Bulqiza Veriore" Zone, according to this point of view, is around 315°. This azimuth is also in line with the general developments of the monoclinic part of the chromite structure of the "Bulqiza Veriore" Zone. The dipping of the Zone structure, referring to the chrome body as a whole, walks in the north-west with different fracture angles in depth, as seen in its vertical projection: initially at angle 25°, further with angle 43° and in depth at 54°. The assumption that there may be a slowing down in-depth is not proven. Changes in the diving angle are also observed in sectorial developments: the first wrinkle, the second wrinkle, the monoclinal development and the southern closure, are changes that lead to the different distances of these parts of the structure when moving from one horizon to another. The collapse of the structure, measured according to a supposed tectonic plan that accompanies its floor, is 66°. In the fall of chrome bodies, noticeable changes are observed in the areas of the wrinkles, but without departing from this phenomenon and other sectors of the structure.

6. SPATIAL BOUNDARIES

Spatial boundaries of the structure "Bulqiza Veriore" area are a tectonic system that closes the chromium body and the accompanying rock mass. The eastern and western planes are accepted as given in the Geological Map of the Bulqiza Ultrabasic Massif of scale. 1: 25000, the southern plane can be identified by the tectonic line that closes sector D of the chrome body structure at each level, the northern plane may be accepted as the one that closes the western wing of the section A of chrome body of each level. These elements are also covered in the vertical projection of the "Bulqiza Veriore" Zone in its cross sectional drawings as appeared in, Fig. 3.

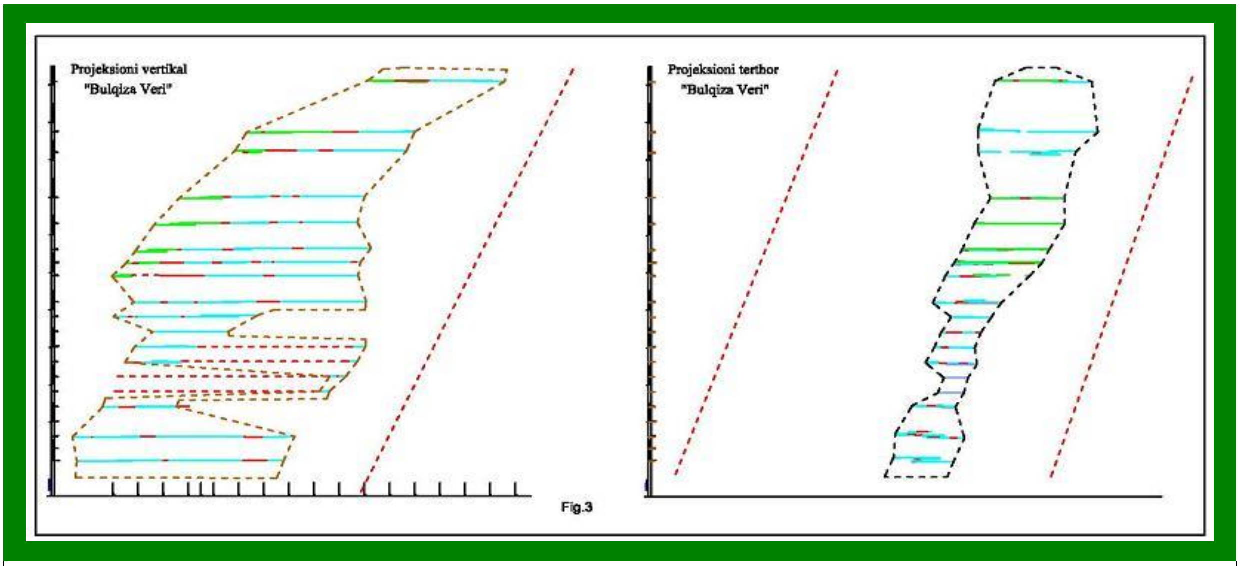


Figure 3 *Vertical Projection of the "Bulqiza Veriore" Zone and its cross-sectional drawings*

7. WHY IS LIKE THIS? AND AN IDEA ON PHYSICAL CHANGES

(a) Overview of the structure

A normal drive pushes to seek answers. The ore body of the chromium in Bulqiza is considered specific because, once from the Geologist Jorgo Kola, was discovered folding or wrinkles as a real phenomenon even for magmatic rocks, which led to new understandings. Even for this, but first of all, for the special conditions that include the rock masses that shaped Bulqiza ore body, I would also use the term- SPECIFIC- here. Geological studies so far have spoken their word for genesis, evolution, stratigraphy, and the boundaries of the ore body (mineral source). Without doing a profession I do not have, I want to look back on the physics of the rock mass transformations that build this ore body. Without being confused in the geological point of view of the problem, here is a new insight based on the physics of fluctuations melting of solid rock masses.

This is simply to give an explanation and, perhaps, to spark a debate on the further development of geological understanding by new thoughts for Bulqiza geology. The problem of rock masses is specified in two types: the chrome body and the peridotite surrounding it. The chrome body has a wider plasticity and a higher formation temperature than the peridotite surrounding it. Separate three stages that make up the long evolution of these two rock masses from shaping to the present state of eastern rise to 70°:

- Uprising in Eastern elevation of the massif
- Chromium body wrinkle (folding)
- Chromium body tectonics

Effective would be the dismantling of these basic physical states that the structure has undergone. The disassembly is carried out despite the assembly, so note the breakup of the evolution of the chrome body structure by stages:

- Decrease the structure to the position before lifting. The western rise of the Bulqiza massif may have occurred after the complete shaping of the BB chromium structure or even during its shaping. Formation, according to geologists who have studied the problem, occurred in an underground camera. Some accept the "residual solution" as the basis, some "new meltdowns that interact with rocky states". In the physical judgment of the hardening process, these do not affect but the depth of the happening of physical / chemical processes being considered.

- Non-considering the tectonics of the structure or avoiding the chromium body cleavage is attempting to recreate the condition of the body before the detaching forces seizures work.
- It initially avoids the influence of significant displacements in the chromium body opening and then acts with the tectonic system created by suppression.
- Waxing or avoiding the effects of wrinkling the structure leads to the recreation of the shaped image of the shaped body.

Here is an illustration given in Figure 4 two examples: level 16 and level 2.

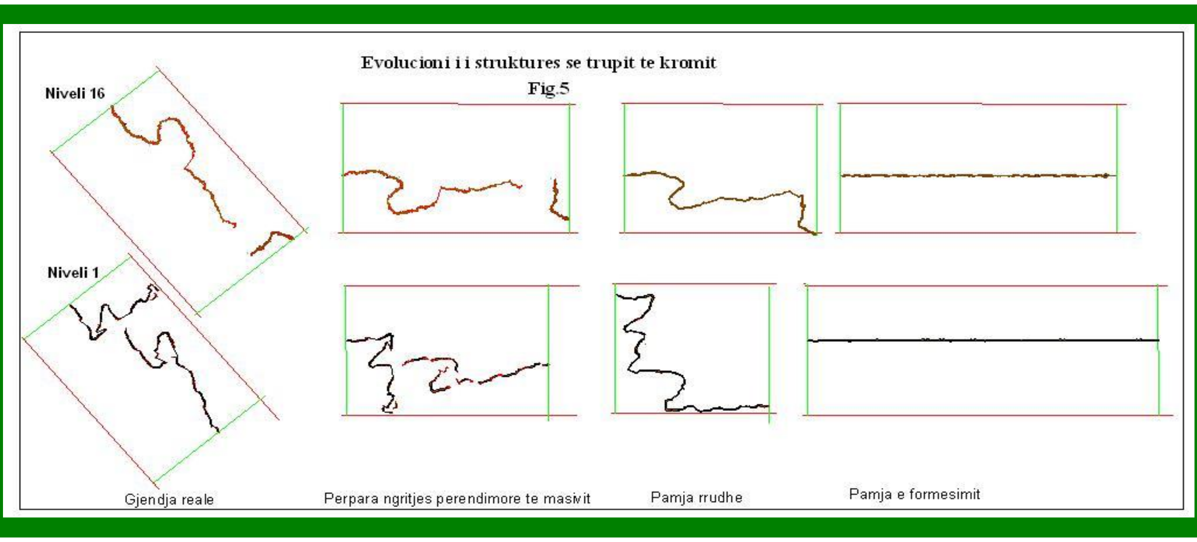


Figure 4 *Evolution of structures of the level 16 and level 12*

These three steps in practice are realized for all the main levels, and the results for the changes are given in table 2.

Note: *1-Lying of the ore body in the direction of the structure, m; 2 –Lying of the wrinkle, m; 3 – Lying of shaping, m; 4- Width across lying of the ore body, m; 5- Width across lying of the wrinkle, m*

From Figure 4 and Table No. 2 we can arrive on some conclusions that how or what happens in the physical transformation process of the linear chromium body from its formation to its present state:

- We have a decrease in body size in lying on average 34.4% for today's condition and 47.85% for wrinkle condition.
- There is an inconsistent increase of 2% of the width in the transition from wrinkle to current condition.
- Large swings from level to level are observed from the average in lengths from formation as well as in shaping, wrinkling with current condition.
- The width of upper level structure (GALLERY.35-Level.5) is on average 56% for the current state and 50% for the wrinkle, higher than in the lower levels (n. 12-16).

(b) An Explain for Physics of Transitions (Changes)

There are several physical conditions that have built up that particular chrome body, which is called the Bulqiza ore body: a wrinkled structure with different wings that stretches a few kilometers in width and in the same length in the depth, tectonically broken into blocks that do not similar and resemble each other, which resembles and does not resemble in vertical levels, which have an almost gradual increase in the content of Cr_2O_3 in the transition from west to east and south to north, etc.

The state of a molten rock mass with a temperature of 600°-800° in the closed underground chamber (room dimensions not yet defined) at a depth of over 3000 m, so a camera pressure above 7.5 ton / m2 is not specific. Loss of internal melting energy by a sliding line slowly sloping downwards, without even avoiding cases of sudden leakage of gases or light melting once, create plastic masses initially in the shapely and growing ore body, and after in the extent of the surrounding melting rocks. This condition misbalances the pressure, which also creates local movements other than the gravitational movement of chromium body. The chromium-shaped body, wrapped by a rocky mass that is suppressed in the melting-hardening passage, is bound to lose its stretch and is wrinkled somewhere or is obliges to maintain a line deformed of tectonics somewhere else. I think it is not a specific development only in Bulqiza.

External interventions that have led to further reduction of the volume and therefore also the chromium body repression, especially in the length on extension and the deformation of the component blocks, are particularly important that need to be revealed and emphasized.

Seeing the development of the chrome body structure of one level, for example Level.16, or Level. 5, in its position before the rise in eastern elevation of the massif, we immediately notice that the tectonic lines of the block displacement give us the concentration by + or - of the pressures, respectively the increase or the expansion of the mass of the surrounding rock there. We notice that rock mass additions come from the floor of the ore body and are not in right relation with the plan of alignment. The complexity of this state of the surrounding rock mass in the transition from the plastic to rigid state makes it work to pull or crush the chromium body, that reels, and it lengthens or thickens it, wrinkles on one side, or creates an elongation at wrinkle curve etc. forms which are revealed in these blocks section. Exactly external interventions have led to some folding of some wing wrinkles in the northwestern part of some levels, creating two wrinkled, sectors, multiform blocks, a southeastern shutdown with spillover effects, and so on.

8. A TYPICAL PROFILE OF CHROMITIC STRUCTURE:

Since the development of the "Bulqiza Veriore" Zone, in the viewpoint of the data from the documentation of the galleries, i.e. from inside, represents changes, it is necessary to build a typical profile. The main changes are:

- In the extension of the chromium structure, (current profiles are built with AZ 260° and they cut not in 90° (per pendulum) but in the non-contact the whole structure. Thus deforms the true appearance of the body to the profiles, artificially grows the surface of the chrome ore body to the profile, thereby reducing the coefficient of the truth of the reported reserves, etc.)
- The true chrome body developments (sectors A, B, C and D) are not reflected as they are and as confirmed in the three dimensional model. And it happens that in profiles that represent main of the northern part of the structure are lost important elements.
- The profile shown in Fig. 5 and the location has been selected to enable a comparison with Profile -15.

Levels	1	2	3	4	6
Gallery 35	349	274	741	217	263
Horizon 104	424	441	722	199	162
Level 1	462	409	804	200	233
Level 3	592	485	1034	214	209
Level 5	554	500	624	182	97
Level 12	567	494	917	111	86
Level 13	462	509	885	112	130
Level 14	558	424	660	159	122
Level 15	551	351	542	123	125
Level 16	518	436	635	108	167

Table 2 *Data on the evolution development of the chromite ore body structure*

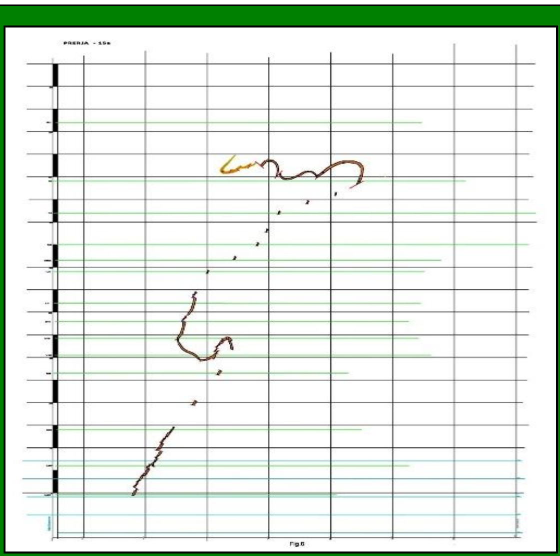


Figure 5
Typical Profile

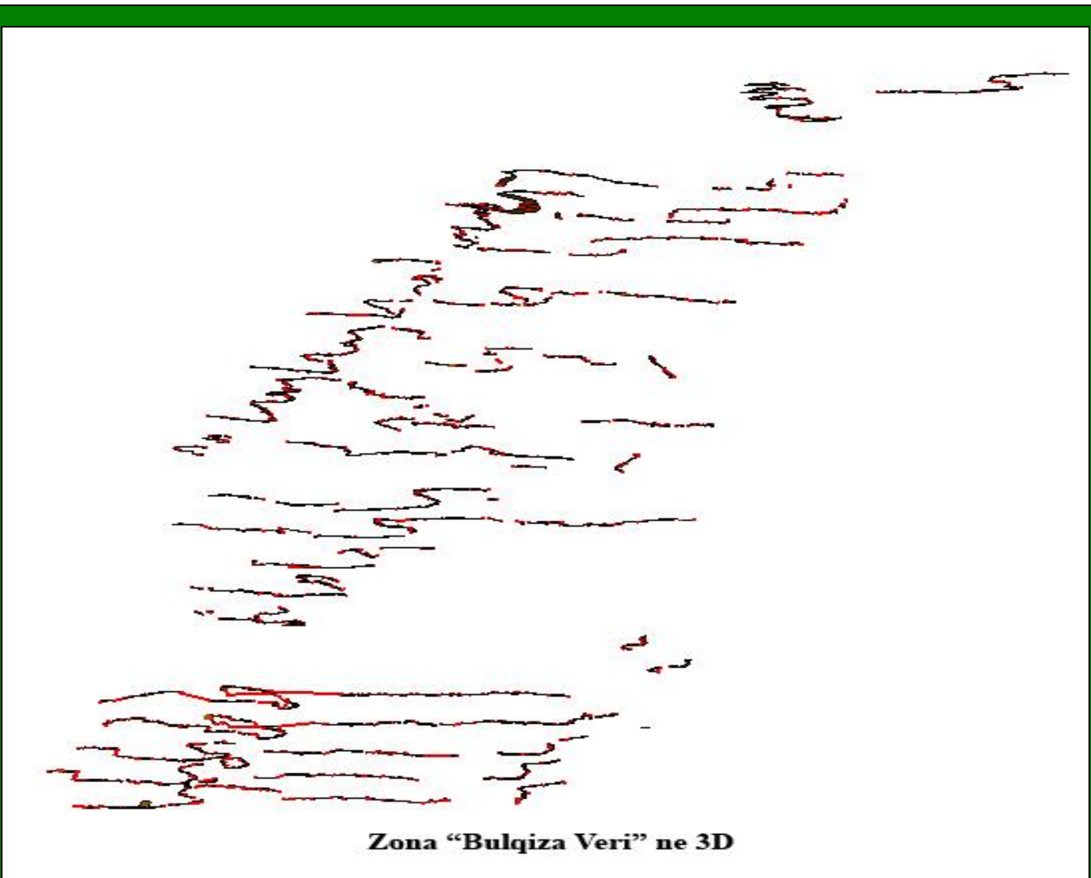


Figure 6 *Northern Bulqiza Zone 3D view*

CONCLUSIONS

1. This is a reflection of the real state of the chromium structure of the Bulqiza North Zone at any level and continuously continuous in Y and X axes. In Z axe are given the levels and not the blocks that bind them, which create a gap in the imagination, especially for the arches in diving. Building blocks according to Z axe was not possible due to the lack of data on the Z direction developments, data that can be found in the exploitation plans of scale.1:200. An approximate view of Z developments can be obtained from profiles. Fig.6, 3D view of the chrome body structure.
2. The presented data, especially the figures and the 3D model, clarify that for the Bulqiza Veriore Zone there is a twist to the extension of the structure that coincides with the gradual rise of the chrome plinth floor to approach its genetic ceiling
3. The presence of different sectors (A, B, C and D) for NW / SE alignment, their appearance and absence in one or the other panel, expresses the complexity of dynamic developments in the physical process of solidification. On the structure of the chromium ore body have influenced the reduction of the volume of the surrounding rock mass, the later developmental process, and the pushing of a new rock mass. The effects on the chromium structure register a shove of diaphyric type at the momentum of chromium plastic state body around the Horizon.104 level and a greater push on the hardened body below the level horizon 6 to level 11 and further in depth.
4. The whole structure of the Northern Bulqiza Zone develops within two tectonic plans with a strong western decline, which excludes chromite body wrinkles in the west as assumed in many geologic ideas * or its turn in-depth twist (whether in the west or in the west east).
5. At the „Bulqiza Veriore „ Zone the folding (wrinkle phenomena) is presented as a specific case of wrinkling of the chromium ore body, but there is no physical reason for the wrinkling of the massif, i.e. of the peridotite rocks, as there is no sign of wrinkles on the ground at these rocks.

RECOMMENDATIONS

1. Revision of prospecting-exploration practices on the continuity of the chromium ore body based on ideas mentioned above;
2. Rebuilding the profiles of the Bulqiza Veriore Area using also the data from the maps of exploitation works in a scale 1/200.
3. Building a three-dimensional model for the development of the tectonics of massif and geochronology of its parts.

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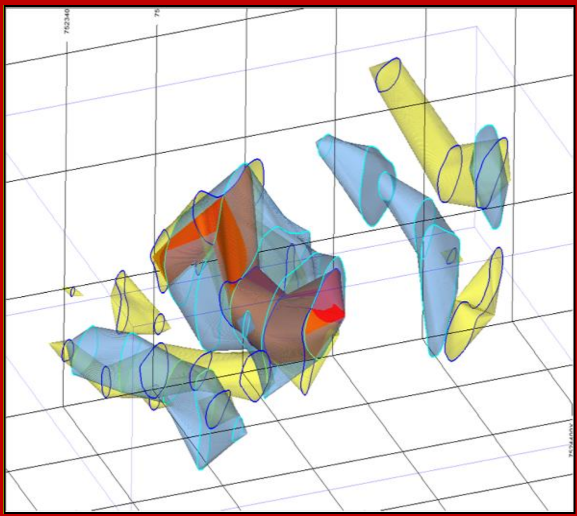
AUTHOR BIO

Martin Cukalla was born on April 9, 1943 in the city of Gjirokastra. In 1966 he completed his studies at the Faculty of Geology and Mining of the University of Tirana, mining branch. He is a Doctor of Science. He worked in Memaliaj coal mine as an engineer and later its chief engineer (1966-1974). For 10 years (1975-1981 and 1985-1987) he was the Director of Bulqiza's chromium mine. At the Institute of Mining (ITNPM) worked as a specialist (1990-1997) and director of this research institute (2000-2006). He is the author of many studies and projects for the exploitation of coal, chromium, copper, iron nickel ores and gravel from riverbed and their impacts on the environment. In particular he has dealt with rocks mechanics and the supporting of the mining workings and mining exploitation spaces.



3D DESIGN OF GEOPHYSICAL INDUCED POLARIZATION AND RESISTIVITY ANOMALOUS VOLUMES

Jeton PEKMEZI **Altin KARRIQI** **Jorgaq THANAS**

Dr. Jeton PEKMEZI[1]
Dr. Altin KARRIQI[1]
MSc. Jorgaq THANASI[2]
[1,2] Department of Mineral Resources,
Faculty of Geology and Mines, Polytechnic University of Tirana. Rr. Elbasanit, Tirana, ALBANIA
E-mail: jpekmezi@gmail.com, Mob: +355682016314
E-mail: altin.karriqi@fgjm.edu.al Mob:+355684874434
E-mail: jorgo.thanas@yahoo.com
Mob: +355674023001

ABSTRACT

Induced Polarization (IP) and Resistivity (R) methods are two of the most well-known and widely used geophysical methods in sulphide mineralization exploration. Correlation of IP and R anomalies are very helpful in delineation of mineralized zones at depth.

The surveys are projected in a regular grid of lines with a constant distance between lines. Usually the results are presented in form of graphs or 2D sections of measured physical parameter. In this paper is treated a different method of IP and R surveyed data presentation. After surveying several lines using 2D sections of IP and R, a 3D shape of anomalous volume can be modelled. Having this model of IP and R anomalous volume can be defined the areas at depth where high IP and low R anomalous volumes are intersected. This intersection can be a possible target of mineralization and can help in drilling orientation. Having drilling core analysis results, we can correlate the results with this anomalous volume and calculate an approximate volume of ore or mineralized zone.

***Keywords**:* Induced Polarization, Resistivity, “Physical Inversion” of IP/R “Real Section”, 3D modelling, anomalous volume

1. INTRODUCTION

Induced Polarization (IP) and Resistivity (R) methods are two of the most well-known and widely used geophysical methods in sulphide mine-ralization exploration. Using appropriate equipment, electric current can be injected in the ground through stainless steel electrodes connected at the end of transmitter array. This current causes a voltage across receiving electrodes. When transmitted current is interrupted, the voltage across receiving electrodes does not drop to zero instantaneously but takes several seconds. This phenol-menon is the so-called induced polarization (IP). This phenomenon is observed when underground contains electronic conducting minerals or clays. This makes IP a useful method in mineral exploration (Parasnis 1986).

Also is known that electrical resistivity of rocks varies from 10^{-6} Ohm.m (graphite) to 10^{12} Ohm.m (quartz). Moisture plays an important role in resistivity values of the rock. Most of dry rocks have high resistivity values, almost insulator. But using the fact that in nature they hold some interstitial water with dissolved salts, they may acquire an ionic conductivity. The pores form, fissures, cracks and fractures also play an important role in resistivity values of the rock. Water bearing fractures zones usually have low resistivity values. Some good electronic conductor minerals like graphite, pyrrho-tite, pyrite, chalcopyrite, galena, magn-tite etc. are representing low resistivity values (Parasnis 1986).

Taking into consideration that in mineralized zones can be surveyed high IP values and low Apparent Resistivity values (when texture of mineralization is massive or veinlet), anomalies of both methods can be correlated with each other to give the most appropriate areas at depth to be drilled. This correlation is known in literature as "metal factor" (Marshall & Madden 1959).

Modelling a 3D anomalous volume for both parameters provides a better idea on this correlation and also helps in borehole design program. Also, after performing the initial boreholes and obtaining their laboratory grades, the approximate ore volume can be calculated.

2. Methods and methodology

Geophysical data were surveyed using both IP and Apparent Resistivity methods through the well-known "Real Section" technique (Langore, Alikaj & Gjovreku 1989) The "Real Section" was introduced by P. Alikaj in 1978 as an original technique of data acquisition, presentation and interpretation. The surveyed results of chargeability and resistivity parameters are presented in a 2D section which provides a very good corroboration with geological structure. Electrical observations with multiple length gradient arrays, from the longest to the shortest current electrode separations are the basis of "Real Section" survey. Maintaining the same lengths of potential dipoles is important in these surveys, as well.

Field data values on every station surveyed with Induced Polarization or Apparent Resistivity are plotted at points located at approximate depth of investigation "Hi". This depth over a known geological cross section is determined experimentally. According to experimental and field results, Hi = (0.125 to 0.2 AB), where AB is the length of the current dipole. Theoretical studies on depth of investigations with direct current arrays in homogeneous media (Roy & Apparo 1971), or of heterogeneous media are supporting experimental depth of investigation. According to Langore, Alikaj & Gjovreku 1989; Roth, 1997; Karriqi & Alikaj 2011; Alikaj et al., 2012, the "Real Section" concept as presented (in quotation marks) is not an exact electrical section of the underlying medium; it is rather a convenient schematic plot of electrical parameters, which has proved successful in many geological environments in Albania, Kosovo, Canada, USA, Latin America and in many other parts of the world providing very accurate results in mineral exploration, engineering geology, hydrogeological and environmental studies. Due to simple anomaly shape, the gradient array is found to be the best array in the IP/Resistivity "Real Section" observations but these surveys can be carried out with any internal electrical field arrays, like Gradient, Schlumberger and Wenner. The "Real Section" is not a mathematical inversion of surveyed parameters. Recently, through special algorithms of proper corrections in current lines distribution at depth, as well as terrain correction, very accurate location of chargeability and resistivity anomalies in a section have been obtained. Conventionally, this presentation of the results has been called by P.Alikaj "Physical Inversion" of IP or Resistivity "Real Section" to distinguish it from a traditional raw "Real Section" presentation.

In this paper are used five Physical Inversion of IP and Resistivity "Real Sections" surveyed in a site for sulphide exploration (Sphalerite, Galena, Pyrite, Chalcopyrite, and Silver). The surveyed lines were in regular grid. Distance between lines was 100m while distance between stations in each line were 50 m. The longest current array was 1,500 m which provides a maximum of 250 m depth of exploration. The length of surveyed area on each line was 1,000 m. The equipment used for survey were the transmitter VIP 10000 and receiver Elrec Pro 10, made by Iris, Instruments, Orlean, France.

The processing and presentation of surveyed data were performed through a proprietary algorithm and program prepared by P. Alikaj and N. Likaj which provided five "Physical Inversion" of IP/Resistivity "Real Sections" for further 3D spatial modelling. Micromine Software was used to obtain spatial model of IP and Resistivity anomalies. Micromine, image 3D georeferencing and appropriate data processing were employed for this purpose. Every anomalous area in the sections was outlined and evaluated separately for the intensity, shape and depth of the anomaly (both IP and Resistivity anomalies).

Careful analysis should be done about type of mineralization that causes the anomaly. The presence of graphite in the section causes the same anomaly intensity like massive sulphide ore bodies for both methods, IP and Resistivity. The presence of clay materials also can cause increased IP and decreased Resistivity values.

Also the presence of metallic pipes or metallic tailings buried underground can cause the same anomalies. Every evaluated anomaly is digitized using strings. Those strings were configured only in the intense part of anomaly or "the heart" of the anomaly.

Because is known that IP or Resistivity anomalous area is as results not only of massive or veinlet ore body but also of other factors like disseminated mineralization, water content etc., string drawing is focused to the most intensive part just to avoid as much as possible the effects of other factors except to massive or veinlet mineralization, which are with economic interest. Spatial projection of strings gives a better idea about the continuity of anomalous volumes between sections. Using triangle method (wireframe), anomalous volumes are created, connecting strings with each other. Wireframes of IP and Resistivity anomalies gives strike and spatial position at depth of this two anomalous volumes and defines the intersection volume (the volume where IP and Resistivity anomalous volumes are intersected). This intersection anomalous volume represent the most probable volume to find massive or veinlet mineralization.

3. 3D design results of IP and Resistivity anomalies

For every 2D section surveyed and processed, a database containing stations coordinates and elevations is created. Knowing coordinates and elevation for every stations makes possible the accurate spatial positioning of the sections in Micromine software worksheet. Figure 1 represents the results of sections georeferencing and presentation. This 3D presentation form of IP and Resistivity sections will help in future processing steps.

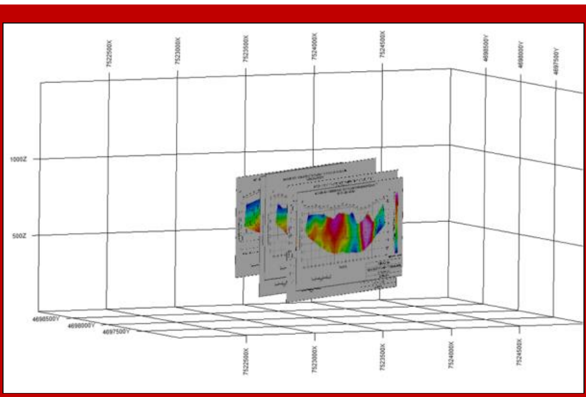


Figure 1 *Spatial georeferencing and presentation of IP sections*

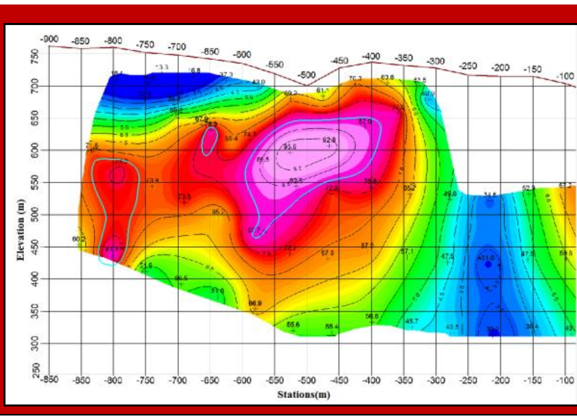


Figure 2 *Strings draw configuring the most intensive part of IP anomalies*

Figures 2 and 3 illustrate the process of drawing strings. Firstly, for each section are evaluated the anomalies, their shape and intensity, and is studied the geological information for possible causes of the anomaly. Strings are drawn in such a way to only determine the highest intensity part of anomaly (considering that the possible ore body is located in the center of anomaly). Each individual section may have more than one anomaly so every anomaly is represented by an individual string. Using different colors in strings drawing helps in further steps of processing.

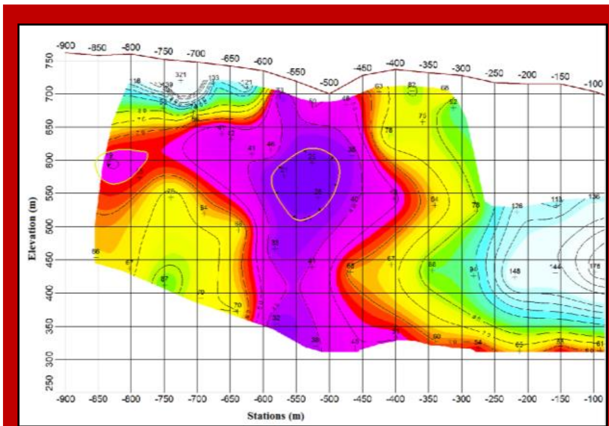


Figure 3 *Strings draw configuring the most intensive part of Resistivity anomalies*

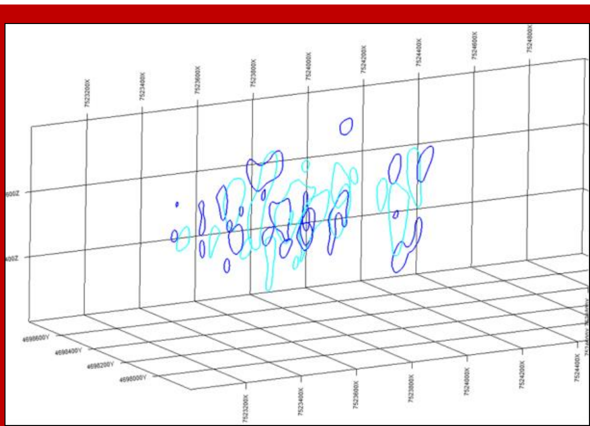


Figure 4 *Spatial presentation of IP and Resistivity anomalies strings*

In string drawing process should be payed attention to different effects that distort the anomaly shape. Near surface ore bodies usually give artifact anomalies at depth, giving idea of an infinite ore body at depth. Those false anomalies should be treated carefully and should not be included at string drawing process or taken into consideration in further analysis. The best anomalies for this 3D processing are the ones of round shape at medium depths.

All drawn strings for every IP or Resistivity section may be presented spatially, using different colors for each geophysical method strings. Figure 4 illustrate spatial presentation of IP and Resistivity anomalies.

Having IP and Resistivity designed strings, is possible to design the wireframe. To do that, all IP strings are connected using triangle method (wireframe). The final result of this process is an IP anomalous volume. The same procedure is applied for Resistivity strings. Different colors are used to differ the volumes.

Figure 5 illustrate the two anomalous volumes. IP anomalous volume is represented by blue color while Resistivity anomalous volume by yellow color. These 3D presentations of anomalous volumes give a better spatial idea about strike and plunge of anomaly and, with the assumption that the anomaly is caused by massive or veinlet ore body, we can configure spatial parameters of ore body. Having into consideration that in mineralized zones, disseminated mineralization has a high value of IP parameter and a Resistivity value equal of hosting rock, the areas with IP anomaly but no Resistivity anomaly can be interpreted as probably disseminated mineralization volumes.

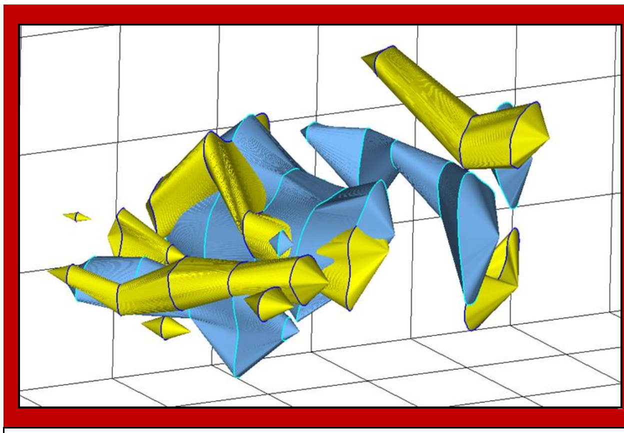


Figure 5
Wireframe design of IP and Resistivity strings

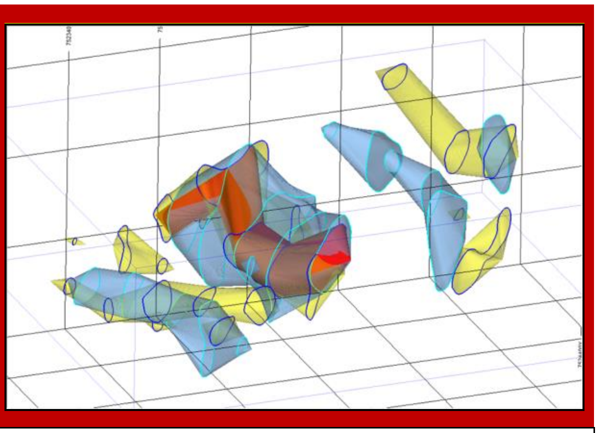


Figure 6
Defined interception anomalous volume (red color) where IP and Resistivity volumes match

Figure 6 represents an anomalous volume (red color) where IP and Resistivity anomalous volumes overlap. Theoretically, when this overlap takes place the chances are high for massive/veinlet sulphide be the cause of anomalies. Nevertheless, several factors should be analyzed prior interpreting the anomalies as caused by a sulphide ore body. The analyses start from the field data evaluation, consideration of geological settings, human impact on the site (buried metallic objects, power lines etc.) and other methodological factors (terrain correction, current lines spread correction etc.). Physical Inversion of IP/R "Real Section", takes into consideration all these factors on 2D interpreted sections. To have a better idea in interception anomalous volume and its spatial parameters, we can fade all other volumes to make visible only the anomalous volume of interest.

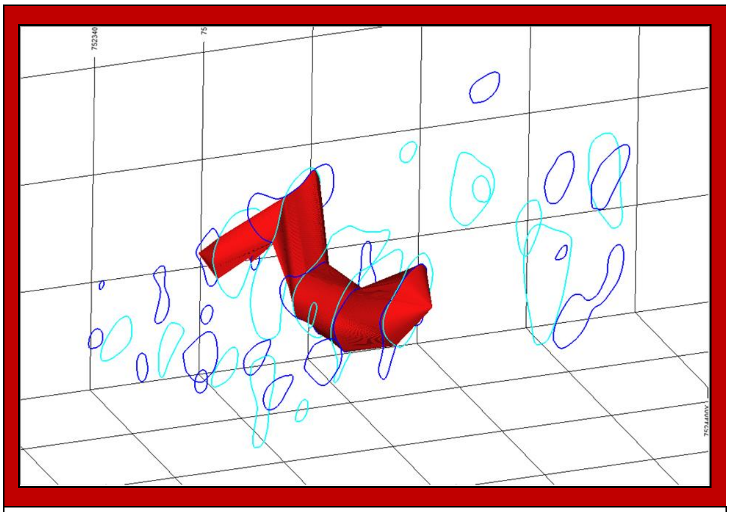


Figure 7 *Interception anomalous volume (red color)*

In Figure 7 is presented only the interception anomalous volume. As mentioned in previous paragraphs, this is the most probable anomalous volume caused by massive/ veinlet sulphide ore body.

Having information on spatial parameters of this volume is very helpful for future steps in exploration.

This anomalous volume helps in projecting drill holes that will intercept this anomaly. Also depth, angle and azimuth of the drill holes can be defined accurately to the core of anomalous volume.

4. Discussion

IP/R "Real Section is a well-known methodology in sulphide mineralization exploration. The recently corrections for terrain and current lines spread at depth have improved the accuracy, transforming the methodology in a 2D "Physical Inversion". Using Micromine, the 2D sections are interpreted in 3D presentation and IP and Resistivity anomalous volumes are designed. It is important to note that these anomalous volumes should **NOT** be consider as ore body volumes. They should be carefully analyzed to find what causes these anomalous volumes. After a complex evaluation is done, drill holes projection can use spatial parameters of the interception anomalous volume as the best possible underground volume to bear massive/veinlet sulphide mineralization. Having the results and laboratory analyses from the initial drillings, the anomalous volume can be used in calculation of approximate ore body volume. The more positive drill holes, the higher the accuracy of this ore body volume can be calculated for the rest of anomaly. Another interesting conclusion is that even other anomalous volumes which are out the interception anomalous volumes should be carefully considered, because they can bear economic disseminated mineralization.

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AUTHORS BIO

Dr. Jeton Pekmezi studied Mining and Surveying at Faculty of Geology and Mining (FGM), Tirana and graduated as “Engineer in Mining and Surveying” in 2007. He completed his PhD Thesis at “Geosciences, Natural Resources and Environment School of Doctorate”, Faculty of Geology and Mining, Tirana. Dr. Pekmezi was a part/time lecturer for 9 years and from 2017 is a full-time lecturer, teaching Geomatics. He is author of many published scientific papers, co-author in more than 6 mining underground projects, and has participated in various international and local scientific conferences and workshops where he has presented his work. He has more than 10 years of successful experience in the field of Mining Exploration and Exploitation working with Canadian and other foreign companies operating in Albania.

Dr. Altin Karriqi studied Geophysics at Faculty of Geology and Mining (FGM), Tirana and graduated as “Engineer in Geophysics” in 2007. He completed his PhD Thesis at “Geosciences, Natural Resources and Environment School of Doctorate”, Faculty of Geology and Mining, Tirana. Dr. Karriqi is an active lecturer at FGM, teaching Geophysics. He is author of more than 15 published scientific papers on geophysics and he has participated in various international and local scientific conferences and workshops where he has presented his work. He has more than 10 years of successful experience in applying geophysical methods in mineral exploration, civil engineering, environmental studies etc.

Msc. Eng Jorgaq Thanas was born in 1964 in the city of Korça. After completing the faculty, his professional work is closely related to the use of natural resources. His main professional contribution is at the National Agency of Natural Resources (NANR) as a specialist in digitalization of mining data and as a specialist in the mining supervision sector for construction mineral permits. He has been member of the Technical Council of NANR from 2013 to 2015 and a specialist in evaluating mining projects. In 2011 -2017 he attended the Doctoral School of the Faculty of Geology Mining and defended the thesis "Designing a technical, technological, economic and environmental management system of mining activity in limestone quarry". He is active in seminars, conferences and congresses both national and international; he is a lecturer at the Department of Mining Engineering at the Faculty of Geology and Mining since 2010.

TECHNOLOGY OF DUMPING IN FUNCTION DYNAMIC OF EXCAVATION OVERBURDEN AND COAL AT THE OPENCAST MINE SIBOFC SOUTHWEST - KOSOVO

Nexhmi KRASNIQI **Idaver HUSEINI**

Dr.Nexhmi KRASNIQI [1]
Prof.Ass.Dr. Idaver HUSEINI[2]

[1*]Kolegji UBT- Lagjja Kalabria p.n Prishtinë, KOSOVO
E-mail: knexhi_ing@hotmail.com; +383 (0)44 860 666
[2] Faculty of Engineering-UT, Tetovë,
Republic of Madedonia
E-mail: idaver_edi@yahoo.com; +389 70830711

ABSTRACT

The main reason of the excavation overburden and exploitation of coal mine Southwest Sibofc is for the needs of TC "Kosovo A and B" to assure sufficient quality of coal, with the necessary and minimum operating costs along. The dynamics of overburden and coal digging in the Southwest Sibofc mine is compiled on the basis of the exploitation project, which means the maximum annual production in the overburden of 13.440 [mil m^3] and coal mining of 7.4 [mil t].

Based on the production of electricity in Kosovo, as well as a gradual increase in electricity consumption, it is necessary to work more intensively on providing the conditions for the establishment of new production capacities of coal. So it is important to make preparations to create conditions that eventually shut down the existing mines and continue with new mines.

One of the problems in providing an area for dumping a significant amount of overburden excavated now considers that it is defined. It is known that existing mines in Mirash and Bardh have an area where you can dump large amounts of overburden.

For allocating area to dumping analysed coverage amounts which digger within the annual period and that can be dumping over the same period and is calculated as the total area and number of measures that can be dumping.

Keywords: *Dumping overburden, coal mining, working dynamics*

1. Geographical characteristics, exploration and production activities

The coal basin of Kosovo field located in the central part of the territory of the Republic of Kosovo and in the western part of the capital Pristine. Productive coal layer includes an area of approximately 300km^2 in the long axis north-south direction. The discovery and extraction of coal started in 1956 in Mirash mine and mine Bardh in 1964. Actual production of coal made only by mine Sibofc Southwest, until the mines Mirash-Bardh are at the stage of filling formations clay as the initial phase of construction of dumping interior and Sitnica sector is being prepared for disposal of ash fresh from TC "A and B".

Determine the location of the internal dumping is not related only to the geotechnical aspects, but also socio-economic impacts, and job security is a major issue in dumping due to the demolished structure after excavation of clay formations. The definition of space for dumping the cover measures is based on the amount of measures that needed to be damp into the existing mining area to the stage of creating the conditions for internal dumping mine in southwest Sibofc.

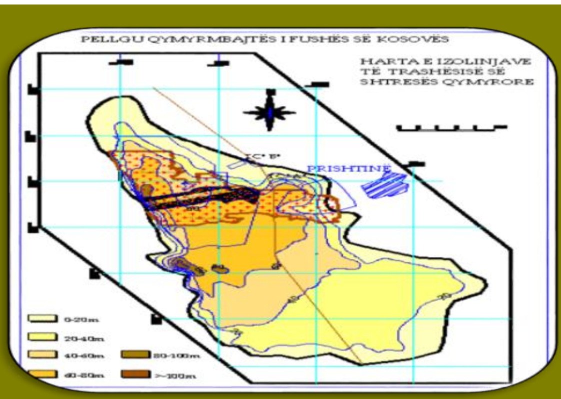

Figure 1
Map of coal basin in field of Kosovo (1:100000)

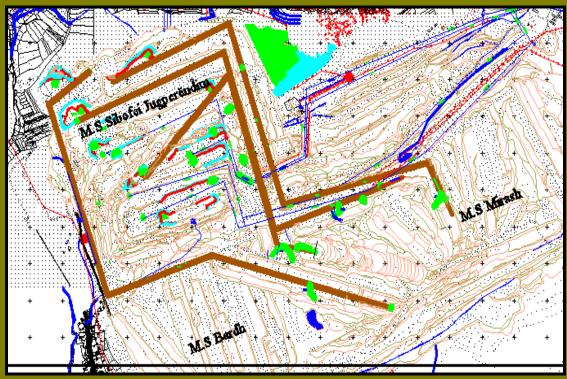

Figure 2 *Map of the situation of the mine Southwest Sibofci and existing mines Mirash-Bardh*

Table 1
Coal production and overburden for the period 1999-2017

Year	Total - Mirash & Bardh & Sibofc & Sitnica	
	Overburden [m^3]	Coal [t]
1999	6,244,556	3,806,385
2000	9,020,155	2,933,517
2001	8,832,516	4,754,465
2002	9,681,958	5,527,900
2003	13,478,488	6,465,954
2004	11,489,825	5,658,369
2005	12,209,404	6,391,138
2006	14,108,159	6,538,966
2007	12,418,719	6,715,352
2008	12,812,946	6,876,160
2009	15,472,356	7,839,173
2010	7,384,962	7,886,060
2011	10,524,396	8,212,103
2012	12,645,604	7,960,579
2013	12,970,702	8,219,393
2014	10,409,153	7,204,211
2015	10,037,332	8,240,994
2016	6,927,806	8,800,848
2017	3,927,768	7,574,697
Totali	**204,320,438.00**	**123,882,631.00**

For this purpose, they are planned areas within the existing spaces mine Mirash and Bardh. With this reduced the cost of using coal mine Sibofc due to the Road to transport the overburden.

To continue with the dumping of measures in existing mines is necessary that front of the works in dump in the last bench instance (+540) moved southwards at a distance of 150 [m] in order to create space for conveyor belts coal highway in this area.

We should remember that the conditions are created for internal dump mine in southwest Sibofc all systems must in turn pass on internal dump in this area. So the dump spaces in existing mines must be dimensioned so as to provide the dump of measures to create favourable conditions for the Sibofc dump mine.

2. EXCAVATION, TRANSPORT AND DUMPING OVERBURDEN

Mines from opening until today, mining activities are conducted in four phased based on the production capacity. Production after the war has continued primarily relying on the needs of TC "A and B", which means a production of about 8.4x106 [t / year] coal. Based on investment for revitalization and buying of new equipment, after the war, soon continued with productive work. Based on the current state of work in the field (for the period when we are addressing this issue, 2016) and designed according to the state of the Medium Term Plan 2013-2017 (compiled by the Institute INKOS), calculated space for dumping is $52.1963x10^6$ [m^3]. For the coefficient k_{sh}= 1.3, enables folding space, is $40.151x10^6$ [m^3 s-m]. Based on the projected dynamics in overburden for $12.5x10^6$ [m^3 / year], dumping space is enough for 3.3 [years].

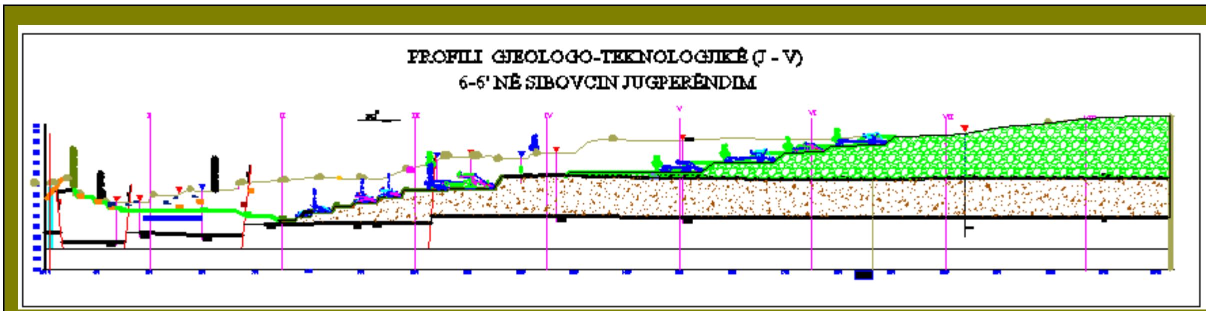

Figure 3 *Profile of the mine - the excavation overburden and coal*

2.1. Technological description of the work for in 2016

Technology work at the mine mainly consists of equipment with continued operation and a part of the auxiliary equipment of discontinued operation. The current production of coal is realized with continual motion device (rotor excavators) and coal transportation to landfills TC "A and B" is realized with belts conveyor. Excavation of overburden realized by type excavators SchRs650 and SRs1300. In excavating of overburden they are engaged four EBS (excavators- belts conveyor -Spreader) systems.

Table 2 *The engagement of equipment to the systems*

System	excavators	belts conveyor	Spreader
S-I-	SRs1300 * 24/5	B=1600[mm]	A_2Rs B=4400*60
S-II-	SchRs650 *24/5	B=1800[mm]	A_2Rs B=5200*55
S-III-	SchRs650 *24/5	B=1800[mm]	A_2Rs B=5200*55
S-IV-	SRs1300*24/5	B=1600[mm]	A_2Rs B=4400*60

Table 3 *Production overburden and coal for 2018 year distributed by systems.*

DINAMIKA E PLANIFIKUAR MUJORE PER EKSKAVATORET NE QYMYR
SIBOVC JP, 2018

		JANAR	SHKURT	MARS	PRILL	MAJ	QERSHOR	KORRIK	GUSHT	SHTATOR	TETOR	NËNTOR	DHJETOR	GJITHSEJT
E-8M	Q_m [t/m	180,000	170,000	120,000	130,000	210,000	200,000	0	190,000	200,000	210,000	210,000	190,000	2,010,000
	T_{ef} [h]	257	243	171 R (15)	R (15) 186	300	286	R	271	143	300	300	271	2,871
	Q_{ef} [t/h]	700	700	700	700	700	700		700	700	700	700	700	700
E-7B	Q_m [t/m	60,000	60,000	80,000	90,000	50,000	60,000	110,000	110,000	80,000	70,000	80,000	70,000	920,000
	T_{ef} [h]	171	171	229	257	R (15) 229	171	314	314	229	R (20) 200	229	200	2,629
	Q_{ef} [t/h]	350	350	350	350	350	350	350	350	350	350	350	350	350
E-4B	Q_m [t/m	80,000	70,000	100,000	70,000	90,000	90,000	120,000	0	0	90,000	90,000	60,000	860,000
	T_{ef} [h]	267	233	333	233 R (15)	300	300	400	R		300	300	200	2,867
	Q_{ef} [t/h]	300	300	300	300	300	300	300			300	300	300	300
E-3B	Q_m [t/m	100,000	90,000	80,000	120,000	120,000	0		70,000	90,000	90,000	70,000	80,000	910,000
	T_{ef} [h]	308	277	246 R (10)	369	369	R		215	277	277	215 R (10)	246	2,800
	Q_{ef} [t/h]	325	325	325	325	325			325	325	325	325	325	325
E-7M	Q_m [t/m	90,000	80,000	130,000	70,000	120,000	90,000	130,000	100,000	120,000	130,000	60,000	80,000	1,200,000
	T_{ef} [h]	200	178	289	156 R (15)	267	200	289	222	267	289	R (10 133	178	2,667
	Q_{ef} [t/h]	450	450	450	450	450	450	450	450	450	450	450	450	450
E-1M	Q_m [t/m	70,000	60,000	50,000	80,000	60,000	50,000	70,000	60,000	50,000	0	60,000	50,000	660,000
	T_{ef} [h]	280	240	200 R (15)	320	240	200	280	R (10) 240	200 R (15)	R	R (15) 240	200	2,640
	Q_{ef} [t/h]	250	250	250	250	250	250	250	250	250		250	250	250
E-1B	Q_m [t/m	70,000	70,000	90,000	90,000	0	60,000	90,000	90,000	70,000	60,000	80,000	70,000	840,000
	T_{ef} [h]	250	250	321	321	R	214	321	321	250	214 R (15)	286	250	3,000
	Q_{ef} [t/h]	280	280	280	280		280	280	280	280	280	280	280	280
TOTALI (t)		650,000	600,000	650,000	650,000	650,000	550,000	520,000	620,000	610,000	650,000	650,000	600,000	7,400,000

Dinamika vjetore sipas muajve dhe ekskavatorëve në Djerrinë për vitin 2018 Sipas Sektor.Djerrines Dl.

			Janar	Shkurt	Mars	Prill	Maj	Qershor	Korrik	Gusht	Shtator	Tetor	Nëntor	Dhjetor	Gjithsej
Sistem.1		$V[m^3/muj]$	240,000	230,000	260,000	280,000	290,000	290,000	290,000					250,000	2,130,000
	SR_s1300	$T_{ef}[h]$	400	383	433	350	363	363	363					417	3,071
	E-10B	$Q_{ef}[m^3/h]$	600	600	600	800	800	800	800					600	694
		$V[m^3/muj]$								290,000	290,000	210,000	290,000		1,080,000
	SR_s1300	$T_{ef}[h]$								363	363	263	483		1,471
	E-8B	$Q_{ef}[m^3/h]$								800	800	800	600		734
		$V[m^3/muj]$	220,000	220,000	270,000	310,000	320,000		240,000	340,000	340,000	340,000	330,000	225,000	3,155,000
	$S_{ch}R_s$ 650	$T_{ef}[h]$	314	314	386	344	356		267	378	378	378	471	321	3,907
	E-9M	$Q_{ef}[m^3/h]$	700	700	700	900	900		900	900	900	900	700	700	809
Sistem.2		$V[m^3/muj]$	40,000	40,000	50,000					65,000	70,000	70,000	60,000	60,000	455,000
	SR_s470	$T_{ef}[h]$	267	267	333					325	350	350	400	400	2,692
	E-5.M	$Q_{ef}[m^3/h]$	150	150	150					200	200	200	150	150	169
Sistem.3		$V[m^3/muj]$	260,000	280,000	330,000	340,000	90,000	370,000	370,000	370,000	365,000	90,000	330,000	290,000	3,485,000
	$S_{ch}R_s$ 650	$T_{ef}[h]$	347	373	367	378	100	411	411	411	406	100	440	387	4,130
	E-10M	$Q_{ef}[m^3/h]$	750	750	900	900	900	900	900	900	900	900	750	750	844
Sistem.4		$V[m^3/muj]$	230,000	230,000	50,000	260,000	270,000	280,000	280,000	280,000	275,000	210,000		250,000	2,615,000
	SR_s 1300	$T_{ef}[h]$	383	383	83	371	386	400	400	400	393	300		417	3,917
	E-9B	$Q_{ef}[m^3/h]$	600	600	600	700	700	700	700	700	700	700		600	664
		$V[m^3/muj]$	35,000	40,000	50,000	50,000	55,000	15,000	60,000	50,000	50,000	50,000	30,000	35,000	520,000
	SR_s315	$T_{ef}[h]$	233	267	333	250	275	75	300	250	250	250	200	233	2,917
	E-1.B	$Q_{ef}[m^3/h]$	150	150	150	200	200	200	200	200	200	200	150	150	178
	TOTALI	13,440,000	1,025,000	1,040,000	1,010,000	1,240,000	1,025,000	955,000	1,240,000	1,395,000	1,390,000	970,000	1,040,000	1,110,000	13,440,000
		TM.1=	3,075,000	$[m^3]$	TM.2=	3,220,000	$[m^3]$	TM.3=	4,025,000	$[m^3]$	TM.4=	3,120,000	$[m^3]$	Tefek[h/vit]	22,104
														Qefek[m³/h]	558

3. POSITION SYSTEMS IN DUMPING

Dumping overburden from the mine southwest Sibofc accomplished with the help a spreader of type A_2RsB -4400x60 and A_2RsB -5200x55. Dumping development is combined with the progress of the front of work from north to south and applied work technology forming block in depth and height. The formation of the dumping is in a function capacity of the system in the overburden excavation, in the area of dump, dumping bench are at different levels for each year of service and length of employment front very short.

Figure 4 *Spreader by type A_2Rs B-5200x55*

Bench are limited by utilizing the mining area. Development of dumping designed bench for 2016 is shown in next figure.

3.1. The technological scheme of dumping with spreader A_2Rs B-4400x60 and A_2Rs B-5200x50

The last link of the technological process of ETP system is spreader (spreader with console), in which adaptability to working environment and right determination of the technical and technological parameters depend on the work of all EBS-system.

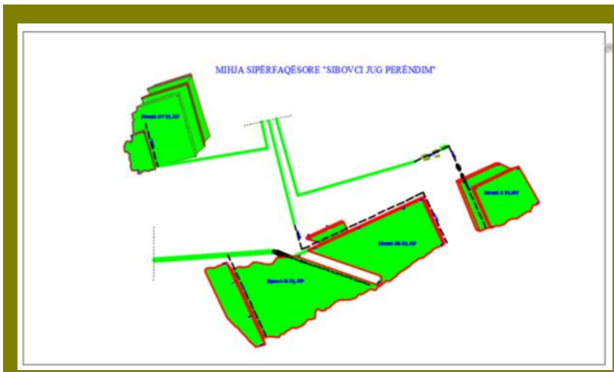

Figure 5 *Level of the benches designed to dump under the EBS-systems by the end of 2018*

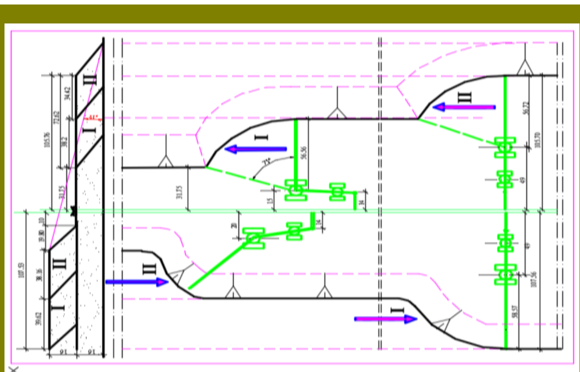

Figure 6
Scheme of spreader A_2Rs B-5200x55

Depending on the length of the console (marksman the wing) designed the way of dumping the excavated measures. The length of the console is very important factor for the stability of the slope in the dump. The length of the console enables measures rocky not dump to the side of the degree of dumping and there by eliminates the possibility of forming slides (additional load) and smashing dynamic in order to drain the rock masses from great heights during dumping under the street of residence of the spreader Figure 7.

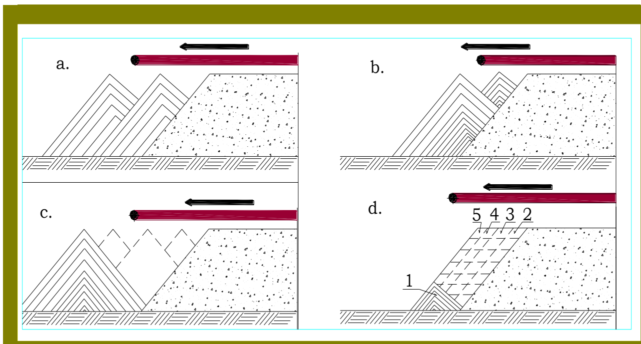

Figure 7 *Dumping measures depending on the length of the console*

Figure 8 *Design of benches to dumping under the 3D model*

Explanation of Figure 7: a. Dumping the console brief; b. Dumping the middle console; c. Dumping with long console; d. Ranking of dumping the long console, in order to reduce the formation of landslides, formed before bench 1, then formed layers 2,3,4,5.

4. THE USE OF THE 3D MODEL TO DUMPING

3D model of folding is a great help to the designer in order to obtain impress on the geographical features of the terrain with no access to immediate location. An important factor in the use of 3D program is a short period to build high quality projects.

4.1. Construction dumping of the 3D model

The way to create 3D models is based on the existing map data a situation. For this purpose, each contour contains an infinite number of points at the same height. Therefore, as digital contours rule should not deviate from analogy contour line. For the construction of 3D surfaces and under the dumping border cartographic data are used by scale (SH = 1: 2500) in which it indicated the existing appearance of the internal dumping Mirash-Bardh. Digitization of mapping is done in Auto CAD Civil 3D 2015. The situation in the state following is designed to dumping under the projected dynamics and progress of the work front.

5. DEFINE THE BOUNDARIES OF THE INTERNAL FOLDING IN MINING MIRASH-BARDH

While constructing and determining the space for dump the inner dumping in Mirash-Bardh was taken into account to ensure sustainable development of the mine, the limit specified in Additional Mining Plan. Therefore, the period of filling in space to folding interior is divided into two phases, as follows:

- Filling the dumping until the quota +540, besides exploitation of coal reserves to the border designed for use.
- Filling level of folding over at +540 to + 600 final

Defining the boundaries, it is made in view of the dynamics of production of mine Sibofc southwest. Determining the space is made for the production of 12.5 x 10^6 [m^3] overburden.

Construction of border dumping is made according to the situation in the mine workings and Southwest Sibofc based on forecasts for the progress of the work front as well as the opening of new mines in the future. Because of expansion of the mine planning Sibofc the southwest there is a need to change the line transport coal power plants in terms of TC "A and B". So a segment of highway transportation is moved from ground level at + 670 to +540 space within the existing dumping in mines Mirash Bardh.

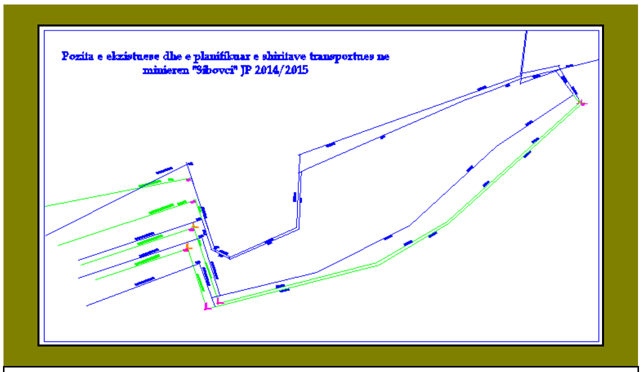

Figure 9
The new position of shipping lines at +540

This shift of shipping lines has made the progress of work in front dumping changed the direction of progress in the east and west of the progress just to the south. Final bench in interior dumping quota is designed to +600. If the quota will be maintained as at the end of dumping may dump altogether 40 x 10^6 [m^3] overburden.
The rest of the folding interior space will be filled along the frontline of the work progress of the new mine which should be built along the southwest Sibofcit mine.

6. CONCLUSIONS

Surface coal mining often changes their working conditions depending on the source but also environmental conditions (the work) in which they work. Also, the use of coal mine in Sibofc - southwest is pit mine.

Mining and Kosovo itself has gone through a difficult period of war, then reconstruction. The level of coal production and overburden always depended on external conditions.

Fortunately, today we have relatively stable situation of supply TC "A + B" coal mine by Sibofc Southwest. Such a situation of developing mining operations in the discovery and extraction of coal made possible by a specific choice and sustainable manner by dumping and dumping relative proximity to the mine, which means short transport length of overburden. Interior dumping area of Mirash-Bardh does not meet the requirements according to the calculation made on the basis of the annual dynamics Sibofc-southwest mine.

The remaining space of the inner dumping measures provides only about 40 x 10^6 [m^3]. All this shows that should be assigned priority in the provision of space for dumping the measures which will be dug up at the end of the mine life Sibofc Southwest.

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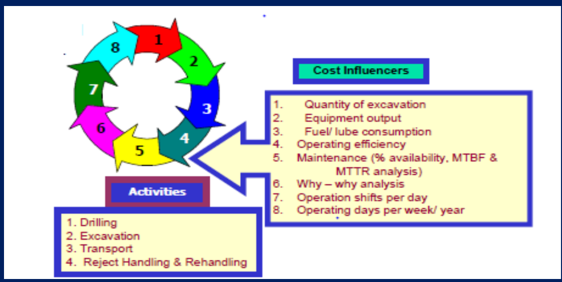
AUTHORS BIO

PhD. Nexhmi Krasniqi has studied for Mining Engineer at the Faculty of Mining and Metallurgy, Mitrovica, graduated in 1993. Until 1999 worked at KEK- Coal Production Division in the Engineering Department as Design Engineer. From 2017 he is a regular lecturer at UBT College, Pristina in the framework of the Faculty of Civil Engineering and Infrastructure and the Faculty of Energy Engineering.

Prof Ass Dr. Idaver Huseini has studied for Mining Engineer at the Faculty of Mining and Metallurgy, Mitrovica,. Since 1990 until 2004 worked at Technical High School in Tetovo. From 2004 he is a regular lecturer at University of Tetovo, in the framework of the Faculty of Applied Sciences.



QUARRY OPTIMISATION
CASE STUDY LIMESTONE QUARRY OF FUSHË KRUJA CEMENT FACTORY


Jorgaq THANAS


Aida BODE


Jeton PEKMEZI

MSc.Eng.Jorgaq THANAS[1]
Prof.as.Dr. Aida BODE[1]**;**
Dr.Jeton PEKMEZI[1]
[1]Department of Mineral Resources, Faculty of Geology and Mine, Polytechnic University of Tirana, Rr. Elbasanit, Tirana, ALBANIA
E-mail: jorgo.thanas@yahoo.com;
Tel: +355674023001
E-mail: aida.bode@fgjm.edu.al;
E-mail: jeton.pekmezi@fgjm.edu.al

ABSTRACT

Increased competition and the spiraling cost of cement production are leading cement manufacturers to identify avenues for reducing costs of input materials. Better quarry management offers significant opportunities for raw material cost reduction which is directly reflected in the minimization of the overall cement production cost. Sound quarry management practices can lead to increased deposit life, improvement in mine productivity, improvement in equipment performance, better maintenance practices, better manpower utilization, etc.

Mining cost is governed by various sub activities, viz. drilling, blasting, and excavation, reject handling, etc. This paper outlines the approach used for identification of cost influencers for each activity and evaluation of their impact on cost of mining operations through benchmarking and discounted cash flow technique followed by identification of action plans to optimize mining operations. Case study of a Mine Optimization study carried out for a limestone mine in central Albania is presented.

Fushe Kruja Cement Factory, Ltd, has carried out quarry optimization for a limestone quarry whereby various components of mining activity are identified as key influencers. The activities are then studied individually and evaluated for their potential for improvement by comparing them with the relevant activities of other similar geographical and geological conditions. The impact of each improvement potential of each activity is then quantified into savings per tone of raw material.
Quarry management and cost optimization are continuous processes which have the potential to glean out the weak but important components of mining operations, address these issues, affect improvement and reap the benefits in terms of reduction in Cost /tonne of raw material.

Keywords: *Quarry, Limestone, Cost, optimization, Fushe Kruja*

1. INTRODUCTION

Cement manufacturers are constantly making efforts to reduce cement production cost. Efficient quarry management is also identified as an important component of cement manufacturing process which offers a vast potential for cost reduction. Holtec Consulting has carried out quarry optimization for a number of limestone quarries whereby various components of mining activity are identified as key influencers. The activities are then studied individually and evaluated for their potential for improvement by comparing them with the relevant activities of other similar geographical and geological conditions. The impact of each improvement potential of each activity is then quantified into savings per ton of raw material.

2. METHODOLOGY

The various components contributing to cost optimization in quarry operations as identified by Holtec are:

- Identification of Objective;
- Identification of improvement area;
- Data collection;
- Situation analysis;
- Identification of cost heads & development;
- Activity-Cost Head matrix; Bench marking;
- Strategic actions;
- Action plans.

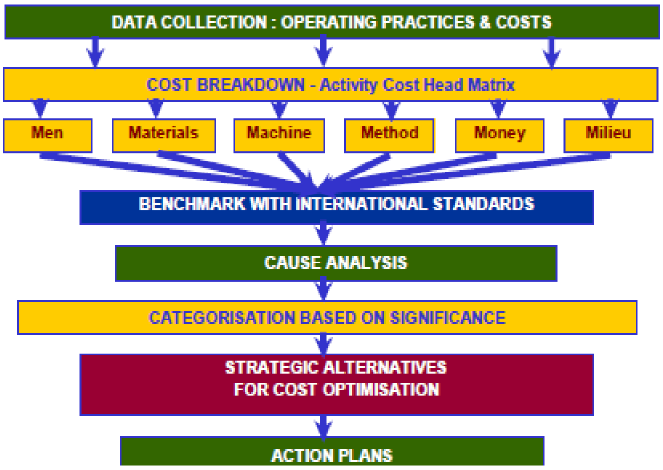


Figure 1: *Components of Cost Optimization*

2.1 Identification of Objective

The first step in the process of cost optimization in quarry operations is to identify the objective since the focal point and priorities of each quarry are different. The basic objectives can be broadly quantified in terms of the major outcomes like optimal utilization of raw material for longevity of deposit life, mine planning and mining infrastructure, equipment productivity/ performance, consumables, maintenance practices, material handling, manpower, and cost. The above objectives are fulfilled using the steps detailed ahead.

2.2 Identification of Improvement Area

A preliminary assessment of mining operations is essential to study the various activities leading to identification of potential areas for improvement and their impact on cost. The assessment and evaluation of operating data is carried out for activities including mine planning, drilling, blasting, excavation, transport, repair and maintenance, reject handling, etc. The outcome of this first hand assessment is analyzed and verified at site and compared to the other mines located in similar geographical and geological conditions. The potential area(s) of improvement and cost saving are then identified.

6.3 Data Collection & Situation Analysis

Mine operation data for the past one to three years of mining operations including raw material characteristics, reserves, mode and method of mining, drilling and blasting parameters, performance and productivity of mining operations are collected. Time motion studies for drilling operations and excavator and dumper operations are also conducted during the course of data collection.

5.4. Situation Analysis

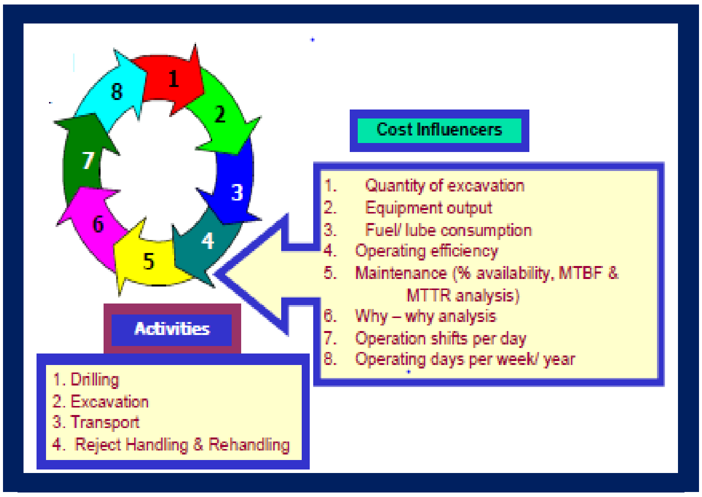


Figure 2 *Situation of analysis*

A detailed analysis of the data collected is carried out for all the mining activities for comparison of consistent performance measures to identify the achievable improvements, which could lead to an impact on overall production cost. For example, by analyzing planned hours, running hours and their availability, utilization and efficiency, productivity of mining equipment can be judged. Similarly, the MTBF (mean time between failure) and MTTR (mean time to repair) analysis is the indicator of the efficiency of equipment maintenance and their productivity.

The situation analysis leads to the identification of areas for improvements and cost influencers that could facilitate the achievement of the cost reduction in the identified activities. The root cause analysis of problem is carried out by application of ***Ishikawa analysis*** and why-why analysis to delineate the possible problems of the cost heads.

5.5. Identification of Cost Heads & Development of Activity-Cost Head Matrix

Analysis of the cost breakdown of individual mining activity is carried out and the areas for cost reduction are identified and ranked in order of their impact on cost so as to give immediate attention to improvement priorities. A cost head matrix for all mining activities and cost components thereof is generated for comparison with other mines operating under similar conditions. The individual cost components with high cost are identified for potential cost reduction.

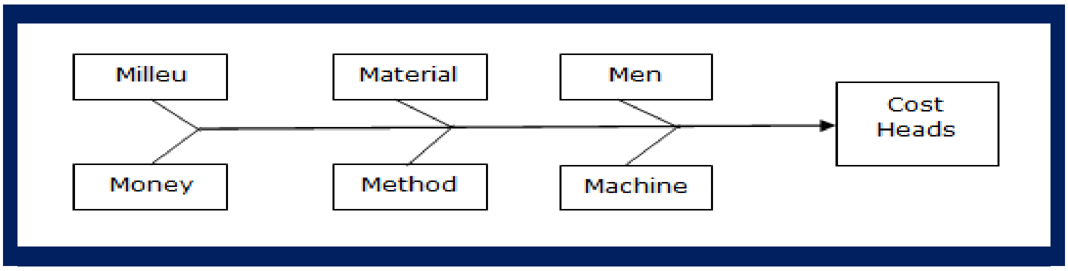


Figure 3 *Identification of Cost heads (**Source**: Ishikawa analysis)*

5.6. Bench Marking & Strategic Actions

Benchmarking is a method for improving and setting goals by comparison with another enterprise involved in similar activities. The performance data for each activity is compared with the corresponding data of each activity from the best operating mine in our database. The main components of bench marking in cost optimization study include drilling rate, drilling output, powder factor, diesel consumption of individual equipment, lubricant consumption, etc.

5.7. Strategic Actions

Various options for improvement are evaluated for areas that need improvement in some respect or the other. The evaluation of positive and negative implications of strategic actions leads to the formulation of actions for implementation

5.8. Action Plans

Formulation, selection and prioritization of action plans in cost optimization is carried out, various options for improvement are evaluated for areas that need improvement in some respect or the other. The evaluation of positive and negative implications of strategic actions leads to the formulation of actions for implementation for different scenarios. The Action Plan details the observations initiating the action plan, recommendation, its applicability, the expected benefits, the proposed timing for implications, the major job activities involved in its execution, its time frame, the capital investment involved, the payback period expected, etc.

6. CASE STUDY

We have carried out a Quarry Optimization and Management Study for a leading cement plant of 1.5 million tonnes per annual capacity. The limestone mine under reference is located in the central part of Albania. Mining was started in 2007. The limestone is marginal grade. About 99.5% of the raw mix comprises of Run-of-Mine limestone and balance 0.5% is iron ore. The inventory of the deposit in terms of quality and quantity of reserves in the form of topographic map with the mining area of the Limestone Deposit is shown in Figure 5.

3.1 Data Collection & Situation Analysis

The actual mine data in respect of different mining parameters was collected and a time motion study was carried out. Data analysis for a few important parameters is summarized below:

- *Blasting*: The powder factor is found to be highly variable.
- *Drilling*: The yield per m is found to be low and there is a 50 % spare drilling capacity.
- *Excavation*: The overall utilization and efficiency of excavators is low even though their availability is high. There is excess excavator capacity.
- *Transport*: The average utilization and efficiency of dumpers is low and the workload on dumpers is unevenly distributed. The material handling by dumpers shows a highly variable pattern.

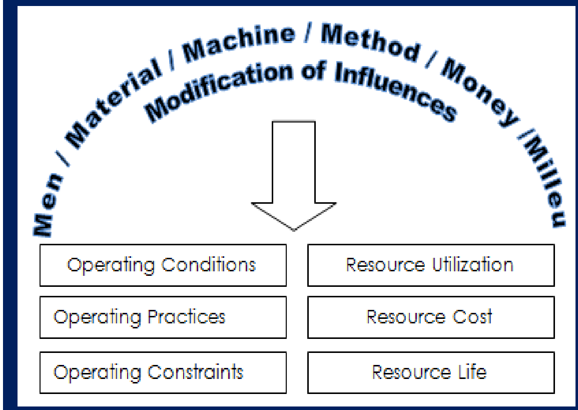


Figure 4
Strategic actions

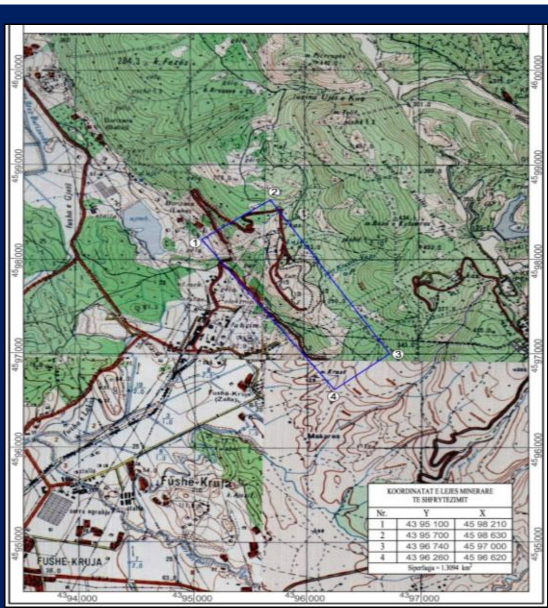


Figure 5 *Topographic Map 1:25 000 with mining area of limestone deposit. Company "Fushë Krujë Cement Factory" Ltd*

3.2 Activity-Cost Head Matrix

The cost of the limestone raising is influenced by various activities involved in the process. The cost for each activity is further governed by various sub-activities. The Activity-Cost Head Matrix developed is shown below. The cost of limestone raising derived is compared and benchmarked against an optimally run mine in a similar geographical and geological condition.

3.3 Strategic Actions

After detailed analysis, a number of Strategic Actions for Implementation have been recommended, few of which are listed below.

Table 2 *Limestone production cost in quarry*
*[**Source**: Data base: "Fushe Kruja Cement Factory", Ltd*

LIMESONE PRODUCTION COST IN QUARRY, Annual Capacity: Q = 1,500,000 tonnes							
No	**Denomination**	**Unit of measurement**	**Norms per unit**	**Material amount**	**Price**	**Value**	**Cost per unit**
I	**EXPLOSIVES**					**27900000**	**18.56**
	Amonite	g/tonne	25	37500	200	7500000	5.0
	AN–FO	g/tonne	180	270000	68	18360000	12.2
	Electric detonator	Pieces/ tonne	0.004	6000	160	960000	0.64
	Tel elektrik Electric wire	m/ tonne	0.06	90000	12	1080000	0.72
II	**Electricity for fraction**	Kwh/ tonne	**1.0**	**1500000**	**8.4**	**12600000**	**8.4**
III	**Fuel**						
	Gazoil for bulldozer	Liter / tonne	0.04	60000	160	9600000	6.4

	Gazoil for aids	Liter / tonne	0.005	7500	160	1 200 000	0.8
IV	**Wages and supplements**	unit	**20**			**16 880000**	**11.2**
V	**Additional costs**						**11.46**
	Instruments & Tools	Lek/ tonne	3			4500000	3.0
	Services to third parties	Lek/ tonne	5			7500000	5.0
	Private security	Persons	6			3400000	2.26
	Taxes					15000000	1
	Stationery					300000	0.2
VI	**Drilling Cost**	Lek / tonne					**16.64**
VII	**Charging Cost**	Lek / tonne					**39.71**
VIII	**Transportation Cost**	Lek/ tonne					**35.03**
	TOTAL COST	Lek/ tonne					**148.2**

Nr	Type of costs	Value of Cost (lek/tonne)
1	Drilling Cost	16.64
2	Explosions Cost	18.56
3	Loading Cost	39.71
4	Hauling Cost	35.03
5	Wages and supplements	11.46
6	Fraction Cost	8.4
7	Fuel Cost	7.2
8	Additional costs	11.2
	Operational Cost	**148.2**

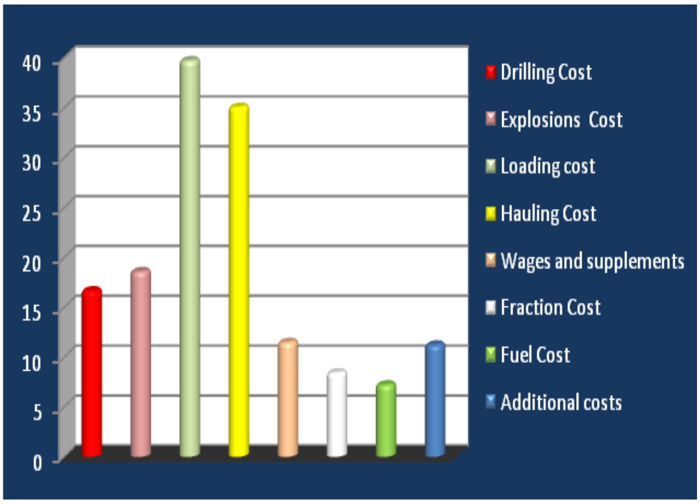


Figure 5 *Table and Chart of Cost elements value*
*[**Source**: Data base; "Fushe Kruja Cement Factory", Ltd]*

Table 3 *Activity Cost Head Matrix*

Activity	Possible Improvement Actions	(+) Implications	(-) Implications
Raw Mix	Use of alternative corrective in the raw mix	▪ Saving per t of clinker ▪ Use of Overburden ▪ Decrease raw mix cost	▪ Segregated mining of alternative corrective
Mine Layout	Relocation of Crusher	▪ Decrease in lead distance from existing distance ▪ Saving in limestone transportation cost ▪ Use of substantial limestone blocked by existing crusher	▪ Payback period of 5 years
Drilling	Improvement in drilling rate	▪ Saving in cost/t of limestone	▪ Improved monitoring measures
	Change in drilling geometry	▪ Saving in cost/t of limestone ▪ Increased yield/m of drilling	▪ Improvement in monitoring of operations
	Induction of Top hammer hydraulic drilling machine	▪ Increased drilling rate	▪ High investment per machine
Excavation	Reduction in diesel	▪ Saving in excavation cost	▪ Cost of engine

	consumption of excavators		improvements ▪ Cost of installation of auto idlers ▪ Planning and supervision efforts to minimize shifting and idling of excavators
Transportation	Reduction in diesel consumption	▪ Saving in transportation cost	▪ Cost towards improvement of ▪ loading area ▪ Close monitoring
	Induction of appropriate capacity trucks	▪ Low fuel consumption ▪ High productivity	▪ High Investment
Outsourcing of Services	Outsourcing of: ▪ Tyre Handling ▪ Engine overhauling ▪ Transmission line over-hauling ▪ Survey work ▪ ANFO mixing	▪ Saving in manpower cost	▪ Increased supervision ▪ Cost of outsourcing

3.4. Action Planning

Areas in which significant improvements could be effected, by virtue of the implementation of Action Plans are evaluated and the cost saving that could be derived after their implementation has been calculated. One such typical Action Plan for improvement in yield per meter of drilling is illustrated ahead.

BENEFITS FROM MODIFY

- Savings in the drilling length: $N_{1,\text{drilling hole}}$ = 3000 drilling holes /year- $N_{2,\text{ drilling hole}}$ = 2222 drilling holes /year = **10892 ml** of drilling or **778** less drilling drilling hole /year.
- A saving of; ΣL_1 = 42 000 m of drilling/year - ΣL_2 = 31 108 of drilling/year = **10 892** m/year
- Working hours savings: 10 892 ml/ year or 20 ml/hour = **544.6** less drilling hours/year ,
- Fuel quantit**y** savings; ΣQ_1 = 309 000 kg of explosive/year **–** ΣQ_2 = 228 866 kg of explosive/year = **80134 kg of explosive/year**,
- Hourly consumption of the drilling machine fuel; = 28 litres/hour = 15 248.8 800 litres /year
- Fuel price: 160 lek/litre
- Income spared only from fuel **= 2 439 808 lekë/year or 22 590.81 USD/year**
- Total cost plummets to 0. 2020 USD/tonne (or 21.614 lekë/tonne) of limestone or 0.3636 USD/m^3 (ose 30.9052 lekë/tonne) or **18.31%,**
- The **s**pecific explosive consumption before the modification; q_1 = 0.20436 kg/tonne or $\mathbf{q_1 = 0.3678\ kg/m^3}$,
- The **s**pecific explosive consumption after the modification; $\mathbf{q_2}$ = 0.15259 kg/tonne or **0.27466 kg/m³**
- The **s**pecific explosive consumption difference **is: Δq = 0. 05177 kg/tonne or** $\mathbf{\Delta q = 0.09314\ kg/m^3}$

TOTAL ANNUAL BENEFIT, <u>of; 416 722 USD/ year or 25.32 %</u>

❖ ENVIRONMENAL BENEFITS AFTER THE MODIFICATION:

In regard with the environmental impact:

- We notice a substantial reduce of the dust emissions in the surrounding environment because we have 544,6 less working hours/year of the drilling machine; Consequently, the dust and gas emissions during combustion will fall back by 18,31%;
- There is a imporant reduce of the explosives that will blast because we have 778 less drilling wells and will explode around 80,134 kg of explosive materials a year, with a saving of 25.93 %.

But on the other hand we will have the quarry atmosphere:

- Less gas emissions due to explosives' blast (NO_X, CO_2, CO, H_2S and SO_2);
- Less terrain vibrations that will be lower compared to national and international standards, significantly improved due to NONEL explosion system usage, achieving PPV values many times lower than allowed values = 50 mm / sec, in the quarry of Fushë Kruja fluctuate by; 0.198 mm / sec for distance from 253 m to 19.51 mm / sec for a distance of 110 m (The location of the blast furnace is 300 m away from the place of explosion) Less noise in the quarry environment and the surrounding one;
- A sharp drop of the fly rock, at a almost insignificant 5 m, 8 m and 10 m distance respectively;
- Savings in the working force that will be in charge of production and ensure safety at work

The cost head wise saving possible due to implementation of 18 Action Plans identified during the study is illustrated in Figure 5. An overall annual saving of 416 722 USD (or 25.32 %) can be achieved in the mines.

4. CONCLUSIONS

Quarry management and cost optimization are continuous processes which have the potential to glean out the weak but important components of mining operations, address these issues, affect improvement and reap the benefits in terms of reduction in Cost / tone of raw material.

Table 4 *Modification and expected benefits*
*[**Source**: Data base: "Fushe Kruja Cement Factory", Ltd]*

EXPECTED BENEFITS			APPLICABILITY
The yield per hole shall be increased to **48.21** t per m **(ton/ml)** in successive steps of drilling as follows: (Modification: Spacing (Distance between two blast holes & Burden (Distance between two blast rows))			
Denomination	**Before modification**	**After modification**	
Spacing (Distance between two blast holes)	4.2 m	5.0 m	Immediate
Burden (Distance between two blast rows)	4.0 m	4.5 m	
Bench height (Constant)	12m	12 m	
Sub grade drilling	2.0 m	2.0 m	
Total drilling per hole	14.0 m	14.0 m	
Specific gravity of insitu rock (limestone)	2.5 ton/m^3	2.5 ton/m^3	
Yield per hole	504 tonnes per hole	675 tonnes per hole	
Yield per meter	36.0 tonnes/ml	48.21 tonnes/ml	
Diameter of drilling hole (Constant)	115 mm	115 mm	

Padding length with explosive charges	11 m	11 m	
Padding length with stemming materials	3 m	3 m	
Increase in output per meter of drilling shall result in a saving of: • With initial target: 0.0135 USD / ton, resulting in saving of USD 20 250 per annum • After full optimization: 0.0199 USD / ton, resulting in annual saving of USD 29 919 USD per annum (or 3 201 413,16 lek per annum)			
MAIN WORK ACTIVITIES			**PAYBACK (years)**
• Computerized recording of drilling parameters • Formulation of procedures to achieve the target • Gradual change in drilling pattern in successive steps • Demonstration blast to achieve optimal output • Drilling/ blasting engineer should ensure accurate blast hole depth and avoid excessive drilling • Inclined drilling of 5° to 7° • Uniform bench height for limestone • Demarcation of drill hole should be done by using measuring tape			Investment is involved
REMARKS			**REFERENCE**
The savings have been estimated,considering the existing drilling costs of USD ,at 0.17 US dollars/ tonne (or 18.36 leke/tonne), or 12.36 %) of limestone,whereas after modification,the drilling cost is 0.1296 USD / tonne (or 14 leke/tonne or 11.86 %); Hence, there has been a 23,76% reduction in the drilling cost			Company supplied data

Table 5 *Modification of the excanhge statement – achiveent and relevant benefits*
*[**Source**: Data base: "Fushe Kruja Cement Factory", Ltd]*

Nr.	**Denomination**	**Before** modification	**After** modification	**BENEFITS**		**REMARKS**
1	Bench height (Constant)	12 m	12 m			
2	Total drilling per hole	14 m	14 m			
3	Padding length with stemming materials	2.0 m	2.0 m			
4	Diameter of drilling hole (Constant)	115 mm	115 mm			
5	Padding length with explosive charges	11 m	11 m			
6	Padding length with stemming materials	3 m	3 m			
7	Spacing (Distance between two blast holes)	**b = 4.2 m**	**b′ = 5.0 m**			
8	Burden (Distance between two blast rows)	**a = 4.0 m**	**a_1 = 4.5 m**			
9	Specific gravity of in situ rock (limestone)	2.5 tonnes /m^3	2.5 tonnes /m^3			
10	Total charges in hole	103 kg/ hole	103 kg/ hole			
11	Drilling hole angle	70º	70º			
12	Amount of limestone per hole	504 tonnes/ hole	675 tonnes / hole	171 tonnes	33,928 %	
13	Rock amount crushed by 1 m of well	36.0 tonnes /ml	48.21 tonnes /ml	**12.21** tonnes/ml	33,928 %	
14	Specific explosive consumption	0.20436 kg/tonne	0.15259 kg/tonne	0. 05177 kg/tonne	33,928 %	
15	Total number of drilling holes	3 000	2222	778 holes/ year	35,01 %	
16	Total length of drilling wells	42 000 ml	31 108 ml	10 892 ml/ year	35,01 %	
17	Total amount of explosive substances	309 000 kg / year	228 866 kg/ year	80 134 kg / year		
18	Drilling speed	20 m/hour	20 m/hour			
19	Fuel hourly	28 litres/hour	28 litres /hour			

	consumption ose Fuel consumption per hour?					
20	working hours savings ?	2100 hours/ year	1555,4 hours /year	544.6 hours /year	35,01%	544.6 hours /year less drilling hours
21	Annual fuel consumption of the drilling machine	58 800 litres /year	43 551,2 litres /year	15 248.8 litres/year	35,01%	15 248.8 litres of fuel per year
22	Income spared only from fuel (Price = 160 lekë/	9 408 000 lekë	6 968 192 lek	2 439 808 lek	35,01%	2 439 808 lek
	Total cost	**148.5 lekë/ tonne**	**118.496 lek/tonne**	**30.004 lek/tonne 0,27781 USD/tonne**	**25,32%**	**45 006 000 lek/ year 416722 USD/ year**

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Authors BIO

Msc. Eng Jorgaq Thanas was born in 1964 in the city of Korça. After completing the faculty, his professional work is closely related to the use of natural resources. His main professional contribution is at the National Agency of Natural Resources (NANR) as a specialist in digitalization of mining data and as a specialist in the mining supervision sector for construction mineral permits. He has been member of the Technical Council of NANR from 2013 to 2015 and a specialist in evaluating mining projects. In 2011 -2017 he attended the Doctoral School of the Faculty of Geology Mining and defended the thesis "Designing a technical, technological, economic and environmental management system of mining activity in limestone quarry". He is active in seminars, conferences and congresses both national and international; he is a lecturer at the Department of Mining Engineering at the Faculty of Geology and Mining since 2010.

Professor Aida Bode was born in 1969. After completing the faculty, her professional work is closely related to the utilization and processing of natural resources, to the maintenance and evaluation of laboratories as a specialist in digitalization of mineral data and in the mineral enrichment’s field. Her main professional contribution is in the Department of Mineral Resource Engineering since 2004, initially as assistant lecturer and now as a professor at the research group on mineral enrichment. She has been a member of the Editorial Board of the Balkanic Congress of Mineral Proccesing in 2005, the Editorial Board of the National Scientific Conference "Natural Resources Potentials, the Basis for a Sustainable Development" October 2011. In 2012 she receive PhD grade and in 2015 Associate Professor's Academic Title. Her scientific contribution is mainly in environmental pollution from the mining industry and from anthropogenic activities in general as well as the enrichment of minerals. Professor Aida Bode is active on seminars, conferences and congresses, national and international; She is a lecturer in the Faculty of Geology and Mining since 2000.

Dr. Jeton Pekmezi; Studied Mining and Surveying at Faculty of Geology and Mining (FGM), Tirana and graduated as “Engineer in Mining and Surveying” in 2007. He completed his PhD Thesis at “Geosciences, Natural Resources and Environment School of Doctorate”, Faculty of Geology and Mining, Tirana. Dr. Pekmezi was a part/time lecturer for 9 years and from 2017 is a full-time lecturer, teaching Geomatics. He is author of many published scientific papers, co-author in more than 6 mining underground projects, and has participated in various international and local scientific conferences and workshops where he has presented his work. He has more than 10 years of successful experience in the Canadian Company in the field of Mining Exploration and Exploitation

SOME IMPROVEMENTS IN THE MINING SURVEYING SERVICE

Skënder LIPO

Gëzim BALLA

Prof.as. Dr. Skënder Lipo[1]
Msc. Eng. Gëzim Balla[2]

[1] Faculty of Geology and Mine, Polytechnic University of Tirana, Albania
E-mail: liposkender@yahoo.com; Tel:+355692127540
[2]Chromium Mine Katjel, Albania
E-mail: gezimballa69@gmail.com

ABSTRACT

Maintaining precision and integrity in performing mining surveying in mines and preparing, updating and controlling graphical and descriptive materials, is of particular importance in the realization of a safe and productive mining activity. The acquisition of a quality surveying service in mines is related to both the preparation of measuring staff and the legal practices that regulate the duties and responsibilities of this profession. The preparation of drafts on the licensing of mining engineers, employment rules, duties and responsibilities, as well as continuous control of works carried out under a functional legal scheme, are the basis for a sustainable and quality development of this service.

This article briefly brings about the experience of regulating the function of measuring engineers in several countries with developed mining industries. By adapting the experience of the operation of this service in some countries with developed mining industries, with the working conditions in our mines, we propose some rules for improving the service of mining measurements.

***Keywords*:** Mine Surveyor, Mining Documentation, Measurements in mines, Practical code of mining surveying.

1. INTRODUCTION

Rapid technological developments and their involvement in business and society have brought about major changes in work and lifestyle. Quick and quality developments in the navigation industry and the mining industry have faced the mine Surveyor with the ongoing challenge of recognizing, adjusting and improving performance in information collection, processing methods and display the measurement results in mines.

The importance of mining works in mines has been documented since the middle Ages, when Agricola, after listing some of the tasks of a mine surveyor, underlined their direct role in the mining operations. Data files with description and graphical material, prepared by the measurement service, are the basis for maintaining the health and safety of mining workers and residents who live and conduct their activity near the mining areas.

The history of disasters in mining includes a number of collapses in underground mining, demolition of various levels, continuous subsidence or fracture of the terrain, flow of water and mud rush from mine, and many other cases caused by inaccuracies in measurements, non-continuity of monitoring measurements, or errors in the preparation and interpretation of mining sketches.

But the task of the measurements engineer in mining is not only of technical nature. Another challenge for the mining surveying engineers is knowledge of mining law demands that supported the ongoing changes in economic and social development of society. These laws require good knowledge on measurements duties to guarantee the life and environmental protection, monitoring and prediction of risks associated with mining activity and improvement the communication and reporting skills, in accordance both with the measurements code requirements and the mining law. In the world practice, regulation of measurements service in mines is based on a series of document of which the most important are:

- Practical code of measurement in mining operation
- Procedure of licensing of mine surveyors
- Procedure of control and inspection of measuring works in mine activity.

These documents are drafted in support of the Mining Law and the Law on Health and Safety at Work. Prepare to be applied by specialized institutions under the executive boards of the mining activities of a country. We bring down the preparation of these documents as a guide for adjusting the mining surveying service in mining practice of our country.

2. PRACTICAL CODE OF MEASUREMENTS IN MINES

Practical code of measurements in mines is compiled according to the requirements of the mining law. An approved practical code should be recognized by mining surveying engineers and must be implemented in measurement works. Standards required to be applied, as well as procedures and practices that should be followed, are clearly stated in the code. Even mining managers should recognize the practical code and check the work done by mine surveyors engineers. Control of work is carried out by specialized persons at the request of the management of the mine and in compliance with the law.

Practical code of measurements in mines must be improved continuously. Dangers and accidents that occur in mine find their reflection in the mining law and lead to improve the measurement practical code in mines. Mine Surveying Code also serves as reference material for state inspectors, during the evaluation of problems associated with health and safety on mining workers. Despite the continued additions, the measurements practical code in mines maintains its standard format where key chapters are:

- General rules where we find data on mining surveying tasks, approved symbols and controls and inspections carried out.
- Standards of measurement and methods for their achievement
- Mining documentation, standard formats and content
- Full documentation for an abandoned mine
- Use and maintenance of plans and documentation of measurements
- Rules and laws where the preparation of this code is supported

Mine Surveying engineers should maintain the direction of all mining works in accordance with the approved project. In the prepared documentation not only new works, but also all earlier ones associated with the mine, or carried out in its vicinity, should be reflected. In their measurements works at different levels of the mine the measurements engineers can use measurement scheme based on local coordinate systems, but maps and planes of the entire mine should be prepared in the state system of coordinates. Geometric elements of layers and different mining works are presented in the maps and cross section or longitudinal section by the approved symbols and conventional signs.

The measurements standards in mining works reflect the best achievements in the field of mining surveying. Standards are presented for major measurement works and determine not only the accuracy of the position surveying points, but also the shape of networks, location of surveying points on the surface and in the mining works, and even the ways of fixing up the surveying points. Measurement methods for achieving the required accuracy from the standards are only recommended, so the mine surveyor may use different methods which guarantee standards of accuracy and ensure the health of workers.

The practical code also attaches importance to the measurement documentation. Measuring books, with accompanying notes and sketches, must be completed and stored according to code requirements. This documentation is assessed as baseline data for all calculations and graphical designation made later, and for that reason it is stored in the mine archives. In measurements with total stations survey books should be kept to record sketches, details of mining works and positions of points in relation to elements of mining works. In these cases, the measurement material is stored in electronic format (recommended to be printed) along with the field survey books of measurements.

Plans and maps of the mine should be prepared by mining surveying engineer or by other operators, but always under his control. Plans and maps should be prepared for each level of mining works and group of levels, according to the requirements of the mine managers. Nomenclature of drawing sheets is formatted from the mine surveyor, while formats of drawing sheets and written information on maps and sections are determined by practical code of measurements.

In addition to plans and maps of mining works, the practical code also requires the preparation of maps of mining subsidence, ventilation schemes, schemes for the elimination of failures, surface maps, service plans on the surface and underground, maps related to ore piles and sterols, etc. "Strong" plans and maps of the mine are prepared in formats of high quality and durable paper. In some cases, paper is strengthened with aluminium plates. Electronic sketches are stored in hard copy and digital format. All mine plans and sections must be certified (sign and date) by the mine surveyor and head of mine surveying service of the mine, before being sent to the Chamber of mines (every 6 months), or before they are sent to archive.

In cases of abandonment of mining works on different levels or zones, the code requires their updating and preparation of "strong" maps. When a mine will be closed, the measurement service must update the status of works in their latest positions and prepare "strong" maps of the mine.

3. LICENSING AND EMPLOYMENT OF MINING SURVEYING ENGINEERS

Mining surveying is a branch of mining science and technology. It includes all measurements, calculations and mapping which serve to the specification and documentation of information at all stages, from prospecting to mining and utilizing mineral deposits both by surface and underground working. Among the main activities of mine surveyor would mention:

- The interpretation of spatial position of a mineral deposit and hosted rocks.
- Providing the geodesic bases on surface and underground to support opening of mining works in direction and position as they are placed on a mining project.

- In collaboration with the geological service, mine surveyor participates in measurements and evaluation on quantity and quality of mineral production. Additionally, mine surveyor measures the volume of mineral and wastes accumulating in mineral and wastes deposits on the surface.
- Monitoring of ground movements caused by extraction of mineral in underground mining, pre calculate the subsidence and forecast the static and dynamic measures for a minimal impact on environment.
- In cooperation with mining authority and local government participates in rehabilitation plan of areas damaged from mining activity.

Performing the above tasks successfully the mine surveyor must have a high professional qualification and be liable to undertake job responsibility. Based on this extensive activity mine surveyor are licensed in two groups:

1. ***The first group*** - authorized person who realize measurement work in open cast mines and underground mines
2. ***The second group*** - authorized person who realize the measurement work in open cast mines.

The difference between the two groups is clear. Engineers of the second group can only work on surface mines. There is not required knowledge in the field of measurements in underground mine operations. In some countries a third license is granted to people *competent in mine measurements*. These persons should have obtained the first two licenses and be active in academic life in the mine surveying and mine engineering fields.

3.1 Who performs the licensing of Mine Surveyors?

In the world practice the institution of license granting is specified in the mining law. Near the mineral chamber that run the country's mineral policy, a committee for the qualification of measurements engineers in mines is raised. This committee, based on mining law and the instructions given by the mineral chamber is committed to:

- Preparation of training material for the interested (published material)
- Organizing training courses in different periods,
- Preparation of a written test exam and test of practical control
- Organizes the written exam and practical test.

Training committees are established by the Chamber of Mines and act in certain periods, according to the requirements for qualification. Composition of training committees is extensive and varies from one country to another. The format of this committee that meets most often is:

- Chairman of the committee appointed by the Chamber of mines
- Measurement engineering near the Ministry
- No more than 3 members – mine surveyor (or competent persons) of measurements from different mines
- No more than 2 members called from scientific institutions.

First the written test is carried out. After correction of the written test, the winners are invited to perform the practical test. This test is performed at the mines under the control of members of the committee. After completing both tests, the chamber of mines, in cooperation with the training committee makes assessment and declares the winners of the license. Names of the winners are recorded in the book of licensed measurement engineers and are published in mining magazines. Enterprises interested on services of measurements engineers, consult published lists and make requests to hire them.

3.2 Who is eligible to apply for license in mine surveying?

Instructions given for this problem are numerous and relate to the specifics of the educational system of each country. Mostly in the guidelines, the right to apply for licenses in mining surveying is granted to people who have basic knowledge in the field of measurement and in the field of mining. A typical application form shall contain the following key documents:
Per license of the first group:

1. University Diploma (professional or scientific master in the field of mine surveying).
2. Certificate of passing the state exam.
3. Documents proving training period near a mine surveying service for a period of not less than 24 months. Description of the types of measurements conducted signed by the mine surveyor engineer.
4. Assessment from the chief of mining surveying service where the applicant has worked.

To get the license (item 3) the applicant must have participated in:

- Measurements for construction of geodetic networks on surface and underground.
- Accurate measurements in polygons on surface and underground.
- Transmission of direction from surface to underground mining works
- Transmission of quota from the surface in underground mining works
- Measurements and calculations of volumes of ore stockpiles
- Preparation of sketches of various levels

For the second group license the following documents are required:

1. Bachelor degree in mining (not less than 30 credits in measurement).
2. Training in measurement field (several months or one year) in mining schools or institutions.
3. Documents proving training period near measurement engineers for a period of not less than 12 months. Description of the types of measurements conducted signed by the measurement licensed engineer.
4. Assessment from the chief of mining surveying service where the applicant has worked.

To get this license (item 3) the applicant must have participated in:

- Measurements for construction of geodetic networks on an open pit mine.
- Accurate measurements in polygons on surface
- Transmission of quota on different levels of an open pit.
- Measurements and calculations of volumes of excavations in open pit mine
- Preparation of sketches of an open pit mine

3.3 Employment of mine surveying engineering

In the mining law of many states is noted that measuring work in mines should be performed by licensed engineers, but not always as a service included in mining staff. The measurements service may so function as a separate company. They undertake to supervise the mining works according to the contracts made by mining enterprises who demand that service. Both sides, measurement service and management of the mine, according to the contract, are obliged to obey the laws and rules of working in mines, including implementation of standards and procedures required in practical code of measurements in mines.

Such a practice work, especially in mines with high yields, has not worked well, bringing problems in the execution of works and the occurrence of accidents mainly due to not updating in time mining works. Brought concerns in this regard (3) noted that the problems faced in some mines, have come from not properly training new measurements staff. In some cases, staff turnover and lack of continuity in taking responsibilities, as well as "command" by far the measurements works, has created problems in meeting the standards of measurement.

Mine surveying service in mines offered by licensed companies must be stable. Mines are engineering objects of high difficulty ratio requiring a continuous measurement and monitoring dynamic extended over time. It is difficult for a young engineer, with only few years of experience, to take the responsibilities of the measurements within a short time.

Therefore, the staff of measurements service in mines should be stable. In cases where for good reasons the measurement engineer should be transferred, the new engineering should be called and work together for a period of time, depending on the capacity of mining works and mineral extraction.

Functioning of measurements service in private companies has the advantages of continuous updating of the personnel with the news in the field of navigation. When the measurement service is offered in engineering objects such as construction of roads, buildings, or in an open pit for inert materials, it can be successful. In the case of mining, mine surveyor engineer must be updated not only with developments in the field of measurement, but also with developments in mining and geology technology.

4. CONCLUSIONS

Mine surveying service in our mines is not at the proper level as required by the development of mining technologies. Lack of qualified specialists in most of the mines that are currently in work should be corrected as soon as possible.

Based on measurements practice in our country, it is entirely possible to develop a draft of practical code for mining surveying service. Operation of this practical code will improve the quality of measurements service in mines and prepare conditions for the development of a practical code for measurements in mines, as an integral part of mining law and safety in mining.

Mine surveying service in mines should be an integral part of the geological and mining service. Approach of this service from a topographic company cannot support the broad range of measuring work in the mines.

Establishment of private companies that will offer the three services, mining, geological and measurement service, will be a good solution and will increase the quality of works in mines, but these is not easy.

World experience in the licensing of specialists in the field of mining surveying should take place as soon as possible in the plans of the competent institutions of the country, to give way to regulating the operation of measurements service in mines.

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AUTHORS BIO

Prof. as. Dr. Skënder LIPO is a lecture in the Department of Mining Resources Engineering. Nowadays Prof. Lipo is chief of Department. With more than 35-year experience, Professor Lipo gives lecture in Master Diploma and School of Doctorates. He possesses good knowledge in 'Mining Measurement" and" Mining Subsidence Engineering" subjects. Professor Lipo has led 5 PhD students and many projects in the area of mining surveying, mining modelling and environmental protection

M.Sc. Gezim Balla is a Mining Engineer at the Chromium Mine of Katjel. In 1992 He graduated as Mining Engineer from the Faculty of Geology and Mining. In 2015, he completed post-university education by defending the micro-thesis in the mining field. He has a 25-year experience as a mining engineer. He works in the mining field, giving a great deal of experience in the exploitation of chromium deposits with limited reserves. He has a continues cooperation with the Department of Mining Resource Engineering.