THE SIGNIFICANCE OF GEOLOGICAL RESEARCH IN THE FUNCTION OF SURFACE EXPLOITATION OF MINERAL RAW MATERIALS

Review
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Abstarct: *The exploration of mineral resources is carried out according to the current legislation, on the basis of which the potential of the area is determined. It is carried out using geological, hydrogeological methods, engineering - geological research, using surface and underground research works and other tests. Research, exploitation and primary processing of mineral raw materials takes place in a certain period of time and under the influence of very different influences. In modern conditions, mines are subject to purchase and sale, and deposits of mineral raw materials are subject to concessions, so their value is determined by the amount of profit, which is obtained by exploitation in a certain period of time. In this context, geological research represents one of the very important input parameters for the process of exploitation of mineral raw materials.*

Key words: EXPLORING, GEOLOGICAL RESERVES, EXPLOITATION

INTRODUCTION

The concept and methods of deposit research are based on the need to determine several parameters, such as mineragenetic characteristics of the research area, genesis and factors controlling the spatial distribution of useful raw materials (sedimentary, structural, lithological, etc.). In addition, the characteristics of the deposit or ore body are taken into account, on the basis of which they are divided into groups and subgroups. The size and complexity of the shape of the morphological characteristics of the ore body, belonging to a certain genetic type, i.e. ore formations, mineralogical composition and its characteristics, as well as the character of the distribution of useful and harmful components and involvement in subsequent tectonic movements represent the starting point in the research process.

The interpretation of the results of exploration works is carried out analytically and graphically and represents a set of attachments that include: structural-geological maps of the deposit, situational plans of wells for surface and underground exploration works, geological profiles of exploratory wells with test results, geological profiles of the deposit, geological map of exploration horizons, overview and detailed maps of tests by geophysical, geochemical and other methods, testing maps with analysis results and the content of useful and harmful components, maps of the area of blocks or profiles for calculating reserves, situational plans of deposits with hydrogeological characteristics, situational plans of deposits with tectonic characteristics, situational plans of deposits with isolines roof, floor and thickness of the ore body, situational plans with interpretation of the physical-mechanical characteristics of the deposit and engineering-geological characteristics of the terrain, situational plans with the interpretation of the quality characteristics of the mineral raw material, which contain a description of useful and harmful components.

METHODS OF GEOLOGICAL RESEARCH

The choice of methods for calculating reserves in a deposit depends on a number of geological, technical-technological and economic factors, the most important of which are the following: the size of the deposit, the geological characteristics of the deposit and their variability, the layout and density of exploration works, the spatial location of the exploration works according to the deposit, the goal of the calculation reserves and other factors.

The shape and structure of the deposit, the maximum and minimum thickness and extent of the ore body were determined by geological research and the execution of investigative works. The research is carried out in the following order:

- reconnaissance and prospecting of the wider research are
- geological mapping of the terrain surface and creation of a geological plan
- locating investigative works (exploratory wells, excavations) and their realization
- geological mapping of the core of exploratory wells and/or excavations with sampling for laboratory tests
- development of a situational and geological plan of the deposit

The deposit is contoured using formal methods of unlimited extrapolation, by drawing the outer contour parallel to the inner one at a distance of up to 1/4 of the maximum distances between exploration works provided for the corresponding group and subgroup of reserves. For reserves of category B and C1, the degree of allowed extrapolation is determined by special criteria for certain solid mineral raw materials, while for reserves of category A, as a rule, extrapolation is not allowed. Taking into account the characteristics of the site, such as size, complexity of shape, genesis, mineralogical composition, structural-tectonic characteristics, as well as the perspective of the area, the deposit is categorized according to the Rulebook on classification, categorization of reserves of solid mineral resources and record keeping.

The following parameters are included in standard tests of physical-mechanical parameters and technical properties:

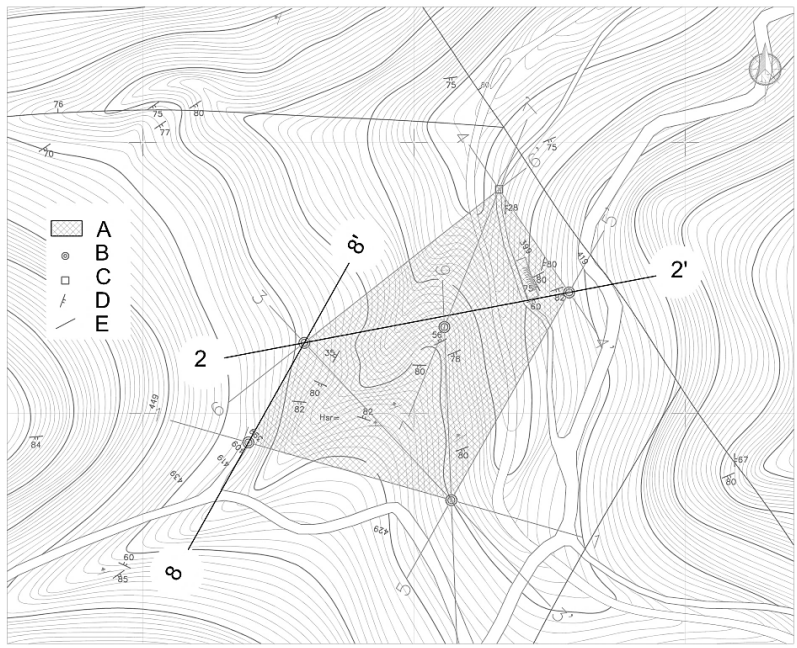
- Volumetric mass was determined on the samples using the paraffin method, by measuring the weight of the sample before and after immersion in water;
- Specific density was determined using a pycnometer on finely ground rock mass particles, in all respects according to the standard, as the mean value of at least two measurements;
- The bulk weight of the bulk mass is determined "in situ", in a vessel of known volume and weight of the bulk material;
- The coefficient of looseness is defined from the ratio of volumetric mass and bulk weight;
- Compressive, tensile and bending strength is determined on roller samples, test bodies, on a hydraulic press with increasing load until the test body breaks. The resistance of the sample to stretching is determined from the ratio of the achieved force on the transverse axis of the sample and the surface of the cylindrical body of the sample. Bending resistance is performed on prismatic samples with roller supports and by measuring the bending moment and the resisting moment. All tests are performed individually on three measurements for each sample;
- The angle of internal friction and cohesion were determined based on the empirical dependence of triaxial tests and resistance to compression and stretching of the corresponding and associated samples, using computer transformation of the compressive and tensile strengths of the same samples;
- The modulus of elasticity and "Poisson's" coefficient are determined on the basis of the obtained mean values of propagation speeds of longitudinal and transverse waves as well as corresponding volume weights in the natural state;
- The speed of propagation of elastic waves, longitudinal and transverse through the limestone massif, was determined based on the measurement of speeds on test samples, test bodies and recording the time of wave passage;
- Drillability and crushing is determined by a method that calculates the depth of penetration of a special blade into the sample with a constant speed of rotation and pressure on the sample for a certain period of time. Crushing is tested based on the drop in weight;
- Abrasiveness is determined by a method where a cylindrical standard made of alloy steel is rubbed against the untreated surface of the sample in a certain time interval while rotating with the application of axial force. The indicator of abrasiveness is the weight loss of the standard.

Geological research works, exploratory excavations and boreholes, enable to obtain the maximum amount of data with the consumption of minimal resources, with which a complete picture of the deposit and its characteristics would be obtained.

CONTOURING OF RESERVES

Among the most important tasks during the exploration of the deposit, and with the goal of calculating reserves of mineral raw materials, is the adequate contouring of the ore, that is, the deposit or part of the deposit in which the reserve calculation is carried out. It actually means drawing the line between ore and tailings. The internal contour of the ore body is drawn by connecting the last positive exploration works according to the fall and extension of the ore body. The outer contour is drawn by extrapolation (where it is allowed) for the distance provided by the regulations. Based on the definition of reserves, the content of the term reserves includes the amount of material that makes up the deposit and certain knowledge of that material and the deposit (geological, mining - technical, technological, economic) (Figure 1.).

When calculating reserves, reserves are separated and separately calculated for parts of the deposit, which are characterized by greater differences in terms of mineral composition, shape, deposit, structure, technological characteristics of the ore, mining-technical conditions of exploitation, degree of exploration or some other characteristics.



A – Reserves of category B; B – Borehole; C – Investigative incision; D – Fall elements; E – Cross fault; 2 - 2' Profile line (8 - 8')

Figure 1, Contouring of geological reserves [2]

The engineering-geological characteristics of the deposit are based for the most part on the stability of rock masses, which represent a productive series in the deposit and most often depend on mechanical discontinuities, their number and spatial orientation, as well as on the method of exploitation. The specificity of the engineering-geological characteristics of the deposit refers above all to the results of the stability test of the physical-mechanical properties of the samples, which are used when adopting the parameters of the working and final slope of the surface mine.

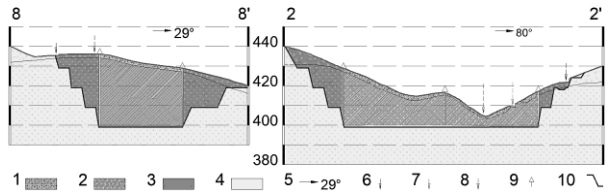
CALCULATION OF RESERVES

Calculation of reserves of solid mineral raw materials in deposits or parts of deposits, outlined by exploration works, can be done using different analytical and graphical methods. The basic principle of all methods is the transformation of ore bodies that are complex into bodies of a simpler shape, whose surfaces and volumes can be easily calculated by applying simple mathematical operations. It represents a complex, responsible and creative geological work, as well as a task that implies the achievement of several goals:

- determination of the total amount of mineral raw materials and the basic geological-economic characteristics of the deposit,
- calculation of reserves according to the types of mineral raw materials,
- calculation of reserves according to categories and their classification and
- determining the technological properties of mineral raw materials.

As the final result of the calculation of reserves in the deposit, the volume of mineral raw material, in its natural state, is obtained, which is expressed in mass units, m³, i.e. taking into account the volumetric mass in tons. The accuracy and reliability of the reserve calculation depends on a number of factors, most of all on the detail of the geological research and on the correct interpretation of the research data.

Some of the most commonly applied methods for calculating reserves are the arithmetic mean, the method of geological blocks, profiles, triangles, polygons, isolines and miniblocks. Figure 2 shows one of the examples of contouring reserves with profile lines, while their position is given in Figure 1.



1 – Unproductive mass (tailings); 2 – Productive mass (raw material); 3 – Overburden; 4 – Floor; 5 – Profile line orientation angle; 6 – Road; 7 – Investigation floor; 8 – River; 9 – Borehole; 10 working level

Figure 2, Geological cross-section of deposits on profile lines [2]

The classification of reserves of solid mineral resources into categories and classes is done according to the degree of exploration of the deposit, the degree of knowledge of the qualitative properties of the raw material and the possibilities of their exploitation [1]. It is used as a basis for the design, opening, preparation and exploitation of deposits of solid mineral raw materials, as well as the construction of facilities intended for the preparation, processing and use of mineral raw materials.

Depending on whether the determined quantities of mineral raw materials in the deposit can be profitably exploited with existing techniques and technology or not, reserves of solid mineral raw materials are classified into balance and off-balance. The balance of reserves is determined by a technical-economic assessment by analyzing geological, genetic, technical-exploitation, technological, regional, market and socio-economic factors and is expressed by natural, value and synthetic indicators and profitability calculation.

Within the framework of the technical-economic assessment, an analysis of factors and their influence on the balance sheet of reserves is carried out and indicators classified into three groups: natural (in the narrower and broader sense), value and synthetic (summary) are presented, on the basis of which the economic classification of reserves is carried out in order to finally received an economic (value) evaluation of the deposit.

CONCEPTUAL SOLUTION OF GEOLOGICAL RESERVES CAPTURE

Exploitation of geological reserves within the framework of the reserves study is carried out by creating a conceptual solution for the final appearance of the surface mine based on previously calculated or adopted structural parameters. The parameters of the mine construction are determined by a number of factors such as: physical-mechanical characteristics of the rock material, the quality of the mineral raw material, the type of mechanization that will be used for the execution of the works, the intensity of the development of the mining works in terms of plan and depth, etc.

For the construction of the working and final slope of the surface mine, the projection of the slope of the floor and the width of the floor are calculated, which are applied directly when drawing the contour of the mine. The slopes of the final slopes of the mine are defined on the basis of a geomechanical analysis of the stability of the final slopes with appropriate safety coefficients according to the objects on the ground. The most important element that defines the works and equipment and thus affects the costs is the overburden coefficient, which represents the amount of overburden that should be dug up and disposed of per unit of mineral raw material.

Based on the analysis of the average content of the useful component, the average thickness of the ore body, the possibility of use, reserves of mineral

raw materials (geological, balance and exploitation), the amount of tailings, the average coefficient of overburden, the production capacity and the life of exploitation are defined. In order to determine the balance of the reserves, as part of the study on reserves, a conceptual solution of the final appearance of the surface mine is being

developed with the ultimate goal of assessing the economic evaluation of the deposit, Figure 3.

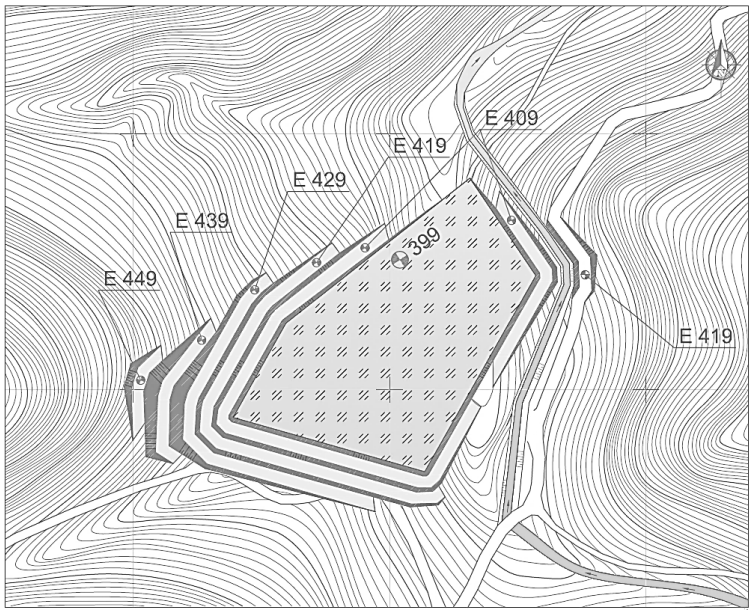


Figure 3, Conceptual solution of the final appearance of the surface mine [2]

CONCLUSION

What is a paradox in the current legislation in this area is that the current Law on Mining and Geological Research no longer recognizes the categorization of deposits. At the same time, the valid law is not harmonized with the current Rulebook on the development of geological research projects and studies. Namely, the current Rulebook still recognizes the categorization of reserves (A, B, C categories), while the current law denies it. This puts the authors of the design and processing of geological research in an almost hopeless position. In this sense, it is necessary to point out the gap between legal and sub-legal regulations, i.e. the pointlessness of the interaction of these legal forms, because of which the practical application of geological research of mineral resources also suffers.

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