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More than 30 years have passed since the first conference on open mining of minerals and stability of the slopes in mines, which proved the prestige of this already traditional forum. Underwater mining was also included, as a thematic area of particular importance.

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I would like to congratulate you and to wish you good health, professional and scientific success. Thank you for your participation which contributes to the success of the conference.

I wish you all fruitful work and good luck!

Prof. DSc Eng. Tzolo Voutov

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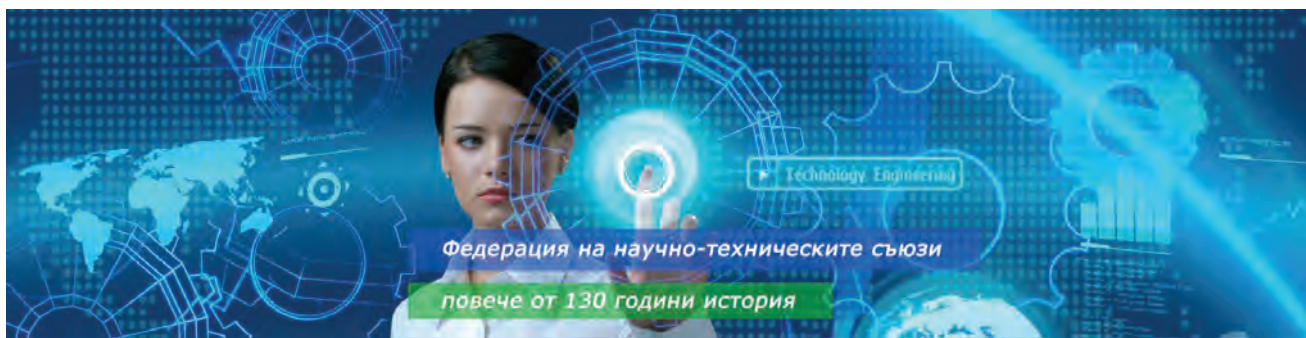


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**NEW OPEN PIT FOR EXPLOITATION OF MINERAL RAW MATERIAL ARCHITECTURAL DECORATIVE
STONE - MARBLE, LOCALITY "SAMARNICA 2", VILLAGE NEBREGOVO, MUNICIPALITY OF DOLNENI
AND MUNICIPALITY OF PRILEP**

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ABSTRACT

The deposit "Samarnica 2" is composed of calcite grey - white marbles. The marble from this locality, according to the conducted examinations, has great physical - mechanical, chemical and mineralogical - petrographic properties. According to the beautiful appearance it is suitable for use as an architectural decorative stone. There were determined balanced reserves for exploitation of the mineral raw material, the coefficient of utilization of the marble mass, the dynamics for annual excavation, necessary mechanization and equipment, place for disposal, basic consumables and protection measures are provided.

An even altitude partition of the deposit has been conducted with designing of exploitation benches with a height of 8 meters, which further ensures optimum utilization of the technical and technological performance of the necessary equipment, while at the same time it is in function of the stability of the working and finishing slopes of the pit.

Key words: Marbles, Open pit, Mining works, Exploitation field

INTRODUCTION

On the locality "Samarnica 2", village of Nebregovo, according to the law, detailed geological investigations were carried out and a Main mining project was made. The prepared technical documentation determines the reserves for exploitation of mineral resource, the coefficient of utilization of the marble mass, the dynamics of excavation by years, the necessary mechanization and equipment, the work force, the place for disposal, the basic consumables and the measures for protection. As the basic product of the mine "Samarnica 2", Nebregovo is the marble blocks used as an architectural - building stone. The technological process of exploitation is based on the application of modern methods for obtaining marble blocks for further processing, i.e. cutting with diamond saw and stove machine, loading blocks with a load shovel and transporting of blocks with trucks to the warehouse for commercial blocks.

GEOMORPHOLOGICAL AND TECTONIC CHARACTERISTICS OF THE LOCALITY

The concession for exploitation of marble "Samarnica 2" is located in the area of the village Nebrebovo, at a distance of about 10 km from the city of Prilep. The wider area of the deposit covers the southwestern slopes of the Babuna Mountain. The deposit itself extends on the western slopes of the hill Crvenica (1244 m asl) at a distance of about 1.5 km from the mine for marble "Sivec". In morphological terms, the terrain of the concession area "Samarnica 2" is slightly hilly and is situated at an altitude of 750 ÷ 800 m. The concession area is located in the edge of the Pelagonia Basin, which is located in the southern part of Macedonia, and because of the familiarity of the Aegean Sea it is characterized by a Mediterranean climate.

According to the tectonic divisions, the concession space is located within the Pelagonia horst-anticlinorium, a first-order tectonic structure that extends over the territory of the Republic of Macedonia, in length of 150 and width of 40 km. Covers total area of about 4000 km² which is 16% of the territory of the



Republic of Macedonia. The Pelagonian massif is a central massif situated in the inner Dinarides - Helinidis. It is a relic of the Grenvil earth's crust, composed of highly metamorphic rocks and granitoids, polyphase folded and faulted, with the present form of a typical horstanticlinorium. In its long history of evolution, several stages of tectonic development can be distinguished, of which the more important are the Prekambrian and Neotectonic stages. According to the division, (M. Arsovski 1997), the Pelagonian massif is divided into two parts, north and south. According to this division, the site belongs to the southern part of the Pelagonia massif and there have been developed a complex of Precambrian rocks and Pliocene - Quaternary sediments.

GEOLOGICAL FEATURES OF THE LOCALITY

With detailed geological mapping of the deposit, as well as with the obtained results from the investigated boreholes, it is concluded that the concession area is quite homogeneous, i.e. it is mainly composed of rocks of Precambrian age: dolomite marble, and in part proluvial sediments.

Dolomite marble (Md). They compose the base of the investigative space and are part of the Marbel series which represents the final level of the metamorphic mass of the Pelagonian massif. In their development marbles were exposed to the strong influence of the metamorphic and magmatic processes that created all the metamorphic rocks. Marbles are white, massive, with good blocking, in places with mica (muscovite) and transformed in cippolino marbles. The saccharoid whiteness of dolomite marbles and the replacement of the dolomite bends, calcite - dolomite and calcite marbles are in white, gray - white and white color. Their orientation is NW-SE. They are characterized with milky white color and very rare small dots of light gray pigmentation. Their structure is fine granular granoblastic and the texture is massive with poor grain orientation. The marbles at the deposit "Samarnica 2" are cracked as a result of neotectonic movements. Generally, their orientation is NW-SE with a incline to the SE and a dip angle of 30-350°.

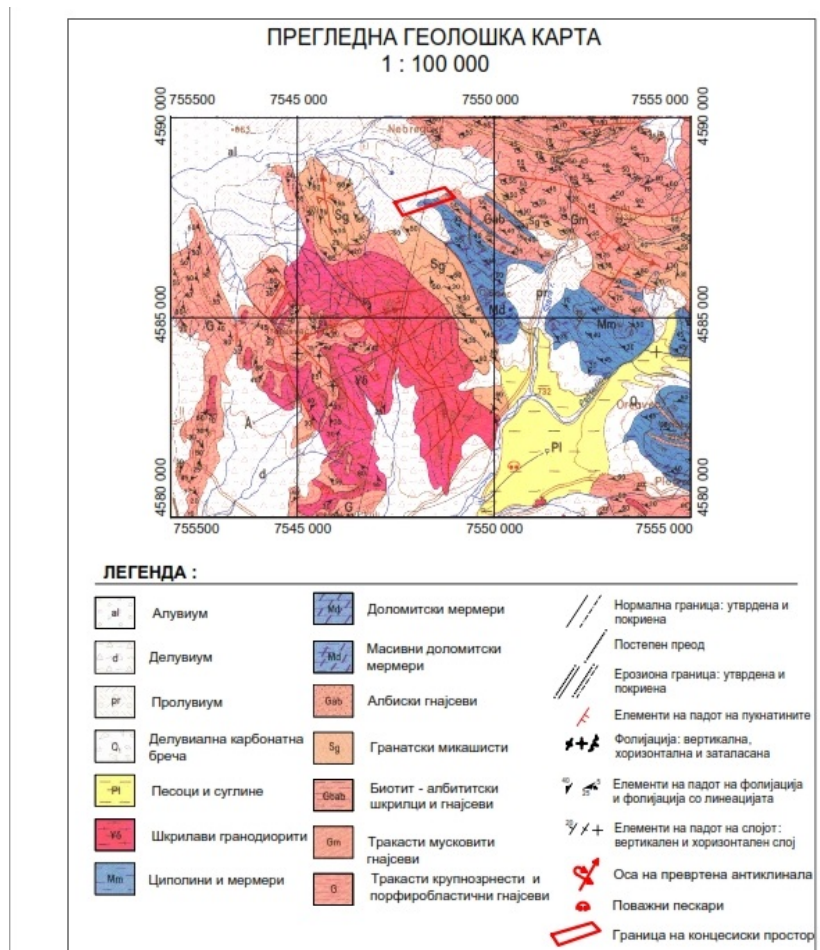


Figure.1 Geological map of the locality "Samarnica 2" village Nebregovo



STRUCTURAL - GEOLOGICAL AND TECTONIC ANALYSIS OF THE LOCALITY "SAMARNICA 2"

The main tectonic characteristics of the Pelagonia crystalline mass are formed by the syngenetic processes of regional metamorphism and folding with plastic current mechanism for simultaneous placement of intrusives from the first granitoid phase. With these processes, large brachyforms and syncline folds and domes were formed. The "Sivec marble mass" in which belongs the deposit "Samarnica 2" as well as the mine "Sivec" extends in NW - SE direction in length of 4 km, with a width of 0.8 to about 2 km and a general decline toward SE with a dip of the foliation of marble from 25° to 40°. On the SW is limited with gneiss - micaschist mass of the Prilep anticline with the Sivec peel - a reverse fault, while on SE, above the marbles is placed mixed series with the Livadiska peel. Toward NW and SE, tectonically is sunk and covered with Pliocene - Quaternary sediments of the Pelagonia neotectonic ridge.

On the cross-section, from the SW to NE, in the lower levels of this marble mass have been developed homogenized, dolomite, white saharoid fine-grained marbles with a tendency of transitions in medium - granular in depth. The same, toward NE irregularly transformed into partially banded grey - white dolomite marbles with nests and calcite tracks, with locally preserved foliation and traces of micro folding. The parts on the east pass into gray middle-granular and banded calcite - dolomite and calcite marbles that represent the highest level of the mass.

The main rupture direction appearing in the investigative area is the fault with orientation NW - SE and dip angle of 85-90° is the main rupture tectonics that influenced the blocking of marbles in the investigated area. Marbles that appear to the south of this fault are cracked without blocking or small local blocking. Foliation in marble masses is probably parallel to the folding plane of the last narrow phase of formation, which usually sinks to NE (30-35 °) slightly wavy. In the concession area are also found cracks along the foliation, which are presumed to be the oldest and are related to the genesis of the marbles.

GENESIS OF THE DEPOSIT

The marble series represents the final level of the metamorphic mass of the Pelagonian massif. It is formed with a regional metamorphism of primary dolomite, calcite - dolomite and calcite limestone. In general, it is concordantly developed through the mixed series and always begins with dolomite and dolomite - calcite marbles, which pass from the horizon of calcite - dolomite marbles, above them are coarse granular calcite marbles and the whole series ends with a thick mass of gray dolomitic marbles. Such a superposition lithostratigraphic structure of the marble series is typical for the northern part of the Pelagonian massif (Karadzica, Jakupica - Porece), where it is fully preserved and is 2.5 to 3 km thick.

In the southern part of the Pelagonia, the upper levels of the series are eroded, but here are best developed dolomite and dolomite - calcite marbles, which toward the upper levels transformed into gray calcite marbles. Such structure of marble masses indicates that their mineralogical composition and superposition are basically related to their primary composition and genesis in geosynclinal conditions. However, marbles were also exposed to the strong influence of the metamorphic and magmatic processes that produced all metamorphic rocks. The influence, especially expressed by metasomatic and thermal processes related to granitoid magmatism, is manifested primarily in the lowest horizons of the marble series by bleaching, homogenization and dolomitization of marbles. Such influence can be seen throughout the entire Pelagonian massif, but it is more remarkable in the area of the Sivec marble mass, where the granitoid masses appear in the immediate vicinity of the marbles. The impact of granitoids on marbles is confirmed by the appearance of corundum, fluoride, paragonite, muscovite, fengite, titanium and epidote minerals in this marble mass. But also the saccharoid whiteness of dolomite marbles in the Sivec marble mass and Kozjak and the replacement of bands from dolomite, calcite - dolomite and calcite marbles in shades of white, gray - white and gray color with distancing from contact, even at the higher levels are the result of the thermal and metasomatic impact of granitoids on marbles.



CONCEPTION FOR OPENING AND WORK OF THE OPEN PIT "SAMARNICA 2"

The exploitation field of the surface mine "Samarnica 2" covers the space necessary for the organization of mining works, the area in which are defined the reserves of mineral raw materials, the place for final products, the construction site for the infrastructure facilities, as well as the storage area for the sterile mass, and the space for processing marble tombolons (Figure 2).



Figure 2. Open pit (exploitational field) with dump spaces and area for infrastructural facilities

The height of the working benches is adjusted to the specific geological characteristics of the deposit, which would achieve the best results in the exploitation of the mineral resource - marble, such as the increase in the dynamics, productivity and the greater coefficient of utilization of the mineral resource. On the basis of previously stated indicators for the open pit "Samarnica 2" is selected height of the benches up to 6 meters. The total number of working benches in the exploitation field "Samarnica 2", provided by the mining project, is five (5). The minimum width of the work stage is 18 meters. From the projected exploitation technology with the main mining project, which is directly dependent on the specific geological features of the deposit, the height of the working benches and the minimum width of the working stage, the angle of the working slope in the surface mine "Samarnica 2" for five benches will be 30° .

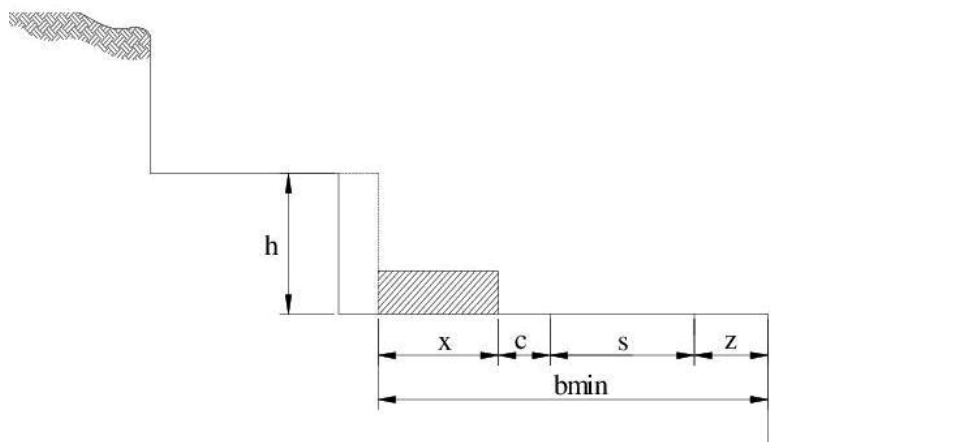


Figure 3. Scheme of minimum width of the working stage



Depending on the geological conditions, crack system, the content of the marble blocks and the anticipated equipment for exploitation the excavated method that will be applied is frontal excavation method with formation of several benches with multiple excavated fields. The technological process of obtaining marble blocks on the open pit "Samarnica 2" will include the following technological operations:

- Making of preparatory "V" and "U" channels in regular exploitation. It depends on the compactness of the stone massif and the movement of the natural cracks through it.
- Separating lamellas from productive benches using diamond welding saw and stove machine
- Damping of the separated lamellas from the marble mass and their shaping in blocks of commercial size (dimensions)
- Loading and transporting the commercial blocks to the open warehouse on the open pit
- Loading and transporting the waste material - crushed stone to the landfill

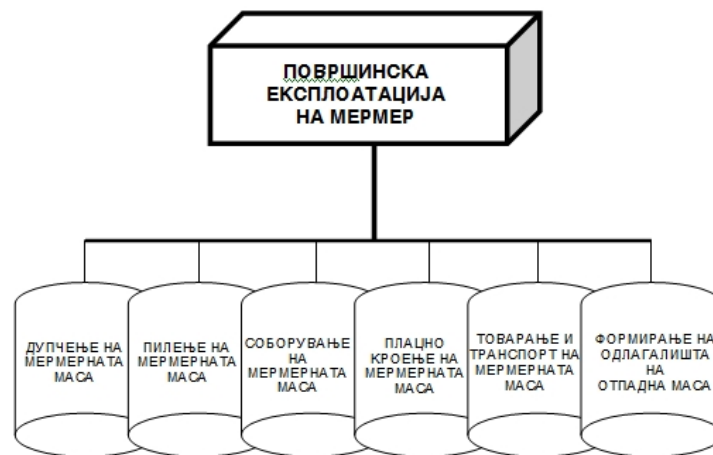


Figure 4. Technological scheme of exploitation

Opening of the benches will be with the following technological operations: 1. Formation of starting plateau, 2. Formation of V-channel, 3. Formation of floor cuttings, 4. V-channel expansion, 5. Forming of benches with height of 6 meters.

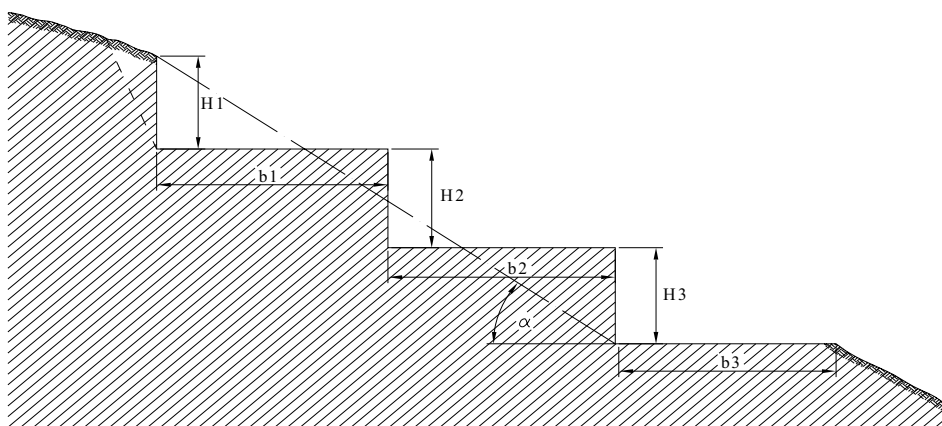


Figure 5. Angle of working slope



CONCLUSIONS

The deposit Samarnica 2, village Nebregovo is composed of dolomite gray-white marbles and a small zone with calcite marbles. The marble of this site, according to the conducted tests, has excellent physical - mechanical, chemical, and mineralogical - petrographic characteristics. According to the beautiful appearance it is suitable for use as an architectural - decorative stone.

The determined geological reserves "B" category amounts to **1.083.784,91 m³** and C1 category of **638.294,94 m³** for exploitation of mineral resource, the coefficient of utilization of marble mass was determined, also the dynamics of excavation by years, the necessary mechanization and equipment, work force, space for disposal, basic consumables and measures for protection.

The limitation of the open pit is performed in the function of maximizing the utilization of the ore reserves of the deposit, which has a direct impact on the life of the mineral resource exploitation. An even altitude distribution of the deposit has been carried out with the design of the exploitation benches with a height of 6 meters, which further ensures optimal utilization of the technical and technological performance of the necessary equipment, while at the same time it is in function of the stability of the working and finishing slope of the pit. The exploitation period of the mine is 23 years with the dynamics of 10 000 m³ of commercial blocks in a year, and it will be achieved in one to two years using the "Frontal excavation method with the formation of several levels with more excavated fields" as well as the Depth excavation method.

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