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UNIONS IN BULGARIA

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PROCEEDINGS

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TOPICS

A. Physical and mechanical rock properties. Methods and means of identification.

B. Stressed and deformed state of the rock mass. Technological solutions and systems for management of the rock pressure.

C. Stability of flanks and slopes.

D. Geodynamic impacts on underground and surface excavation equipment. Geomechanical securing of rock falls and landslides.

E. Mine-surveying methods and computer systems for monitoring and management.

F. Ecology and environment protection.

DEFINING ENGINEERING-GEOLOGICAL CHARACTERISTICS OF THE TERRAIN PLANNED FOR FOUNDATION OF SMALL HYDROPOWER PLANT "ZRNOVSKA RIVER 353"

Risto Dambov[1], Gorgi Dimov[2], Vojo Mircovski [3], Ilija Dambov[4]
[1] University Goce Delcev, FNTS, Stip, R. Macedonia, ristodam@gmail.com
[2] University Goce Delcev, FNTS, Stip, R. Macedonia, gorgi.dimov@ugd.edu.mk
[3] University Goce Delcev, FNTS, Stip, R. Macedonia, vojo.mircovski@ugd.edu.mk
[4] Dam-Explo, Doo, Executive manager, Radovis, R. Macedonia, dambov2007@gmail.com

ABSTRACT
At the entire surface of the investigated field can be seen metamorphic rocks from Rifei -Cambric age. According to the mineral composition it can be concluded that it is albite-quartz-sericite- chloritic schist (Sab).
From the ground provided for the foundation of the dam for small hydropower plant "ZRNOVSKA RIVER 353", from the stage of geological investigations it is conducted a detailed engineering geological mapping of the terrain and for this purpose are analyzed 15 measuring points. The measurement points were set up along the selected profile lines. In this paper are given engineering-geological properties of the rock mass along the profiles 4-4 ', 6-6', 8-8 'and 3-3'.
The most important issue during the mapping of schist metamorphic rocks is to determine foliation which is a predisposed structure to the development of cracks. On the investigating area are developed three families (systems) of cracks with different orientation, angle of decline and density.
At the terrain along the researched profiles at first is calculated RQD parameter (indicator of the quality of rock mass) and also has been given the classification of the rock masses according Bienawski (RMR system 1989) i.e. defined quasi homogeneous zones in the rocky massif.
Of these quasi homogeneous zones has been performed categorization of the rocks according to construction norms GN-200 (Brauns-Stini) and defines the method of excavation in them.
Keywords: engineering geological mapping, cracks , profiles, RQD parameter, RMR system

1.0 INTRODUCTION

This geological prospection on the ground provided to foundation of the dam Zrnovska river is defined lithologic construction and tectonic framework of this location and could also analyze and monitor the drilling-construction works, which took place at that time, along the route of the pipeline. These things in principle allow detection of surface of decomposed material and deposits of the diluvium so we had the opportunity to explore fresh kept suckerless to see lithologic and tectonic structure of these rocks. Also, on the ground that provided the foundation of the small hydropower engineering was performed detailed geological mapping of the terrain where there were analyzed 15 measuring points, measured in available kept suckerless of uninterrupted (unchanged) rock mass.

This paper will show the most significant (cross section 4-4') and influential features of the terrain for the successful foundation of the dam.

2.0 GEOLOGICAL CHARACTERISTICS OF THE TERRAIN

Across the entire surface of the investigated field, metamorphic rocks of Rifej-Cambric age can be observed. According to the mineral composition and degree of metamorphism we can conclude that it is albite-quartz-sericite-schist chlorotic (Sab). These shales are seen all over the field. Certain parts of the shales are covered with delluvium material (d) or Colluvium sediment as you can see in Figure 1.

Colluvium silt. This is a modern alluvium product from mining, located down on the researched area and lies directly on albite-sericite-quartz schist. It is composed of disconnected pieces of broken mined rock mass mixed with humus and clay material from delluvial sediment and has a variable thickness from 10 cm to 1 meter.

Deluvium (d) - deluvial material location of the subject covers parent rocks from metamorphic complex. It is composed of unbound humus, clay and sand material, mixed with crushed stones from parent rocks nearby. Delluvial deposits in this region have a greater importance and have a thickness up to 1 m in some of the natural hollows. They consist of unsorted pieces of metamorphic downloaded from the surrounding hillsides mixed with clay and sands material.

Albite-sericite-quartz schist chlorotic (Sab) - These rocks are of the rifej-kambrij age and are the main rock mass in the construction of ground on which the future facilities for MHC Zrnovska river will perform.

The structure of the shale is porphyryblastic. It is gray in colour, light brown to green. Minerals participating in the construction of the rocks, albite, sericite, muscovite, chlorite and quartz as major minerals, and like accessory minerals arise biotite, garnet, tourmaline titanite, magnetite and others.

These rocks are also known as,, green series " rocks. A key feature of these rocks is intense schisting, where the direction of spreading is NW-SE. These rocks are characterized by filites appearance, in gray-greenish color, perfect small schisting with very large thickness of the series.

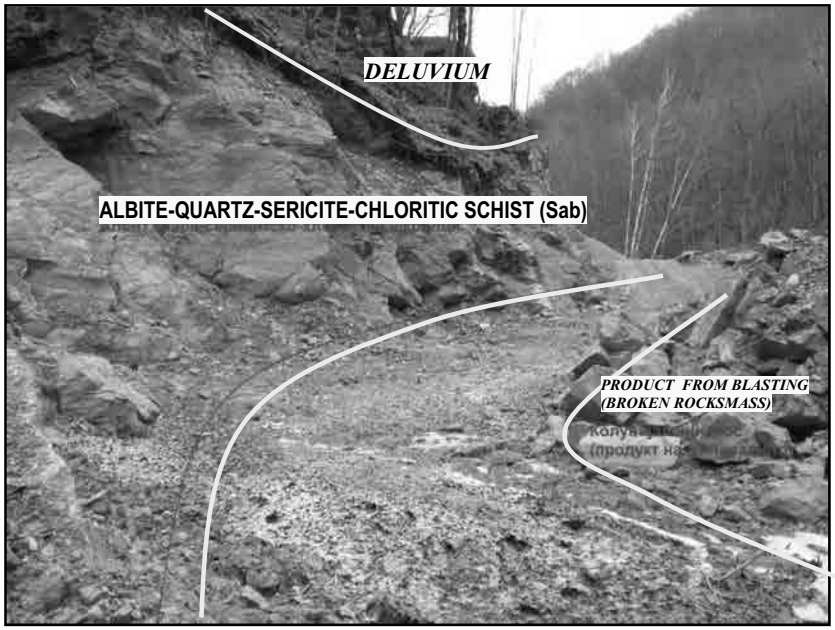

Figure 1. Spatial distribution of lithologic members on the ground

3.0 ENGINEERING AND GEOLOGICAL CHARACTERISTICS OF THE TERRAIN

The detailed engineering and geological mapping on the ground is the basic field method to define the composition and the compound of the field. With engineering and geological mapping, in addition to collecting data on geological - genetic characteristics, properly locating additional field investigations were performed, and detailed mapping was conveyed of all visible kept suckerless, as well as monitoring of the geological boundaries of basic rocks on the ground, represented ravines, gullies, landslides and others.

Considering the geological structure of the investigated field, from engineering-geological point of view, we conclude that the terrain is built from unbound sediments (delluvial and colluvial deposits) and tightly bound petrified metamorphic rocks of a series of quartz-albite-sericite chlorotic schists.

3.1. Unbound and friable sediments

The group of non-aligned sediments includes: colluvial sediments and deluvial sediments (d). They consist of unsorted pieces of metamorphic downloaded from the surrounding hillsides mixed with clay and sand matter. Featuring variable physical and mechanical characteristics, they have uneven consolidation and grain size as well as variable porosity. Belonging to the group of soft rock and ground, and classification of Brauns-Stini, which is the basis for construction standards MG-200 and they are in category III or IV in which excavation can be done by digging.

As mentioned before colluvial deposits were the products of blasting and mining and have little thickness. They have similar physical mechanical properties such as deluvium and the recommendation is that sediment during construction of civil works should be completely removed.

3.2. Firmly tied rock masses

From engineering - geological aspect, albite-sericite-quartz schist in chloritic researched area belong to the tightly bound rocky masses, which in general posses favorable mechanical characteristics as geotechnical environment. They are cracked in the form of blocks of various sizes mainly with "dm", and meet with "m" dimensions. These rocks under GW-200 are in category VI and in them the excavation can be performed only by blasting.

Modern geological processes are with low intensity and have a negligible effect on the stability of the ground, and are manifested in the formation of thin layer that can undergo rinsing and creating smaller ravines.

4.0 ENGINEERING GEOLOGICAL MAPPING

As mentioned before, engineering-geological mapping is performed on visible kept suckerless of rock mass surface. In our case the mapping is made on 15 kept suckerless of albite-sericite-quartz schist chloritic because the foundation of the building was planned there. At the request of the investor the terrain was mapped along selected cross section lines. The task allotted to us was to analyze the engineering-geological properties of the rock mass along the profiles 4-4 ', 6-6', 8-8 ', 1-1' and 3-3 '. In this paper will be presented only the results of mapping performed along the profile 4-4' because to display all accounts exceeds the required amount of paper. Engineering geological position of this profile is shown in Appendix 1.

The first thing that can be seen from the observation of all 15 measuring points is that the investigating space developed three families (systems) cracks of different orientation, ern angle and density. The most important thing in mapping such sorted metamorphic rocks is to determine foliation structure which is prone to developing cracks. It was confirmed by the investigated area and global conclusion is that cracks in the plane of foliation are most dense and most prevalent in this area.

Figure 2. Crack in plane of foliation

The following are the elements of a decline in the cracks and density of the same for all 15 measuring points spaced along the four cross section lines. For profile 4-4 'on 5 measuring points we measured the following values:

Table 1.

Cross section 4 – 4'		
Measuring place	Elements of a decline in the cracks	Density of the cracks
M1	188/85 in foliation	2 m'
	337/64	2 m'
	36/20	1 m'
M2	228/78 on foliation	2 m'
	352/70	2 m'
	60/35	1 m'
M3	260/70 in foliation	2 m'
	60/38	3 m'
	350/58	1 m'
M4	240/68 in foliation	7 m'
	310/78	3 m'
	350/30	2 m'
M5	280/60 in foliation	6 m'
	80/40	3 m'
	350/35	2 m'

Measuring points M1, M2 and M3 are located on the left (south) side of the profile 4-4' whereas the measuring points M4 and M5 are located on the right side of the profile. The following table presents the level of cracking on the measuring points and determine RQD - parameter which is an indicator of the quality of the rock mass.

Table 2.

Measuring points	Density of the cracks			Jv (p/m^3)	RQD %
	G1 (p/m')	G2 (p/m')	G3 (p/m')		
M1	2	2	1	5	98,5
M2	2	1	2	5	98,5
M3	2	3	1	6	95
M4	7	3	2	12	75
M5	7	3	2	11	75

As can be seen from the table above under parameter RQD, both sides of the river are actually unhomogenous zones with different qualitative properties of the massif. Additionally, the classification of rocks according Bienawski (RMR system 1989) on both sides of the river is shown.

Table 3.

Parameter	Measuring point (M1, M2, M3)	Points
Compressive strength σp (Mp)	50-100 Mp	7
RQD (%)	90-100 %	20
Distance between cracks (m)	0.6-2 м	15
Condition of Crack	Wavy fissured surface (<1mm)	20
State of underground water	Poorly humidity	10
Orientation of cracks	Good	-7
Total Points		**RMR (65) II class Good rock mass**

Table 4.

Parameter	Мерно место (M4, M5)	Бодови
Compressive strength σp (Mp)	50-100 Mp	7
RQD (%)	50-75 %	13
Distance between cracks (m)	60-200 mm	8
Condition of Crack	Wavy fissured surface ,(<1mm)	20
State of underground water	Poorly humidity	10
Orientation of cracks	Good	-7
Total Points		**RMR (52) III class Good rock massiv**

As can be seen from the foregoing profile on 4-4 ' were developed two unhomogeneous areas with clear differences in the quality of the rock masses. The left side of the river (M1, M2, M3) according Bienawski (RMR system 1989) is ranked in class II and is defined as a **good rock mass** while the right side (M4, M5) is classified in as favorable rock mass or class III.

5.0 EFFECTS OF PERFORMED BLASTINGS

On the investigated field blasting of rocks was carried out from left (south) side of the river for the needs of the investor for foundation of buildings. As a result, the release of energy from the mining in the rocky massif, developed mechanical cracks (small cracks) which unlike genetic cracks do not occur in systems with limited spreading. Figure No. 3 and 4 shows how these cracks look like and concludes that they are strongly tight, have no significant length and the terrain occurs without any regularity. Usually, they are very short, 1 to 2 meters in length, and do not represent a major risk factor that could endanger the stability of the slope or would reduce the range (class) of the rocky massif.

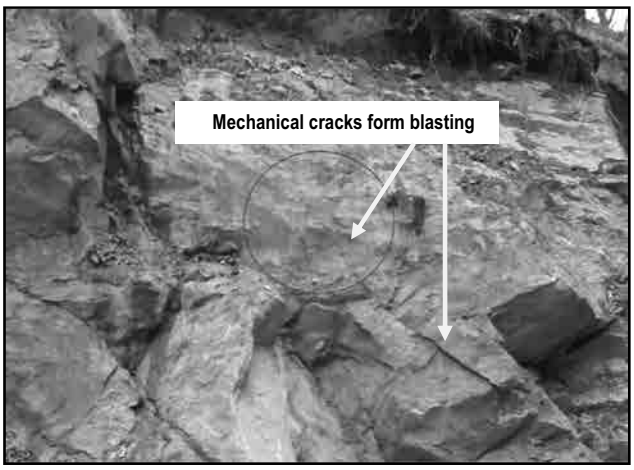

Figure 3. Mechanical cracks incurred by blasting of the massif

Figure 4. Occurrence of the massif and loosen tendency to slip landslide blocks

Far greater risk from the effects of mining is the occurrence of loosening the rocky complex along the genetic cracks. This phenomenon can be seen in Figure 4.

Due to the high percentage of RQD parameter, and as a result of loosening of cracks, gravitational sliding is possible, as well as a landfall of large blocks of rock mass which can potentially endanger the buildings.

6.0 CONCLUSION

- In general, investigating rocky massif is in a very good position in terms of cracking and physical mechanical characteristics on it. If you take into account that the terrain is built from old metamorphic rocks (although schist is not pronounced) we must emphasize that it is a true rarity to have this big axial strength of it (nearly 100 MPa) and as high percentage of RQD indicator .
- Most of the ground after Bienawski is rated class II and is defined as a **good rock mass** and only a smaller part as favorable rock mass or class III.
- In the area of the profile 4-4 '(where the water intakes should be placed) rocky massif is divided into two unhomogenous zones. One is the area outlined in northern profile or right bank of the river, is actually the lowest ranked area with the lowest percentage of RQD. We recommend if possible to avoid this area for foundation of buildings. Ten meters below the river near the profile 6-6 ' already exists a higher quality environment for the foundation. But although this area is the weakest of the whole researched area however towards its class expressed by RMR and RQD parameters represents a solid environment for construction.
- Mechanical cracks caused by blasting in this environment are short and strongly fisted and they do not pose a significant risk factor that could endanger the stability of the slope.
- The emergence of loosen along the rocky complex genetic cracks as a result of blasting represents a possible danger due to the occurrence of gravitational sliding and landfall of large stone blocks. We therefore recommend before building facilities, that all such areas should be stabilized by removing mealy parts (blocks).

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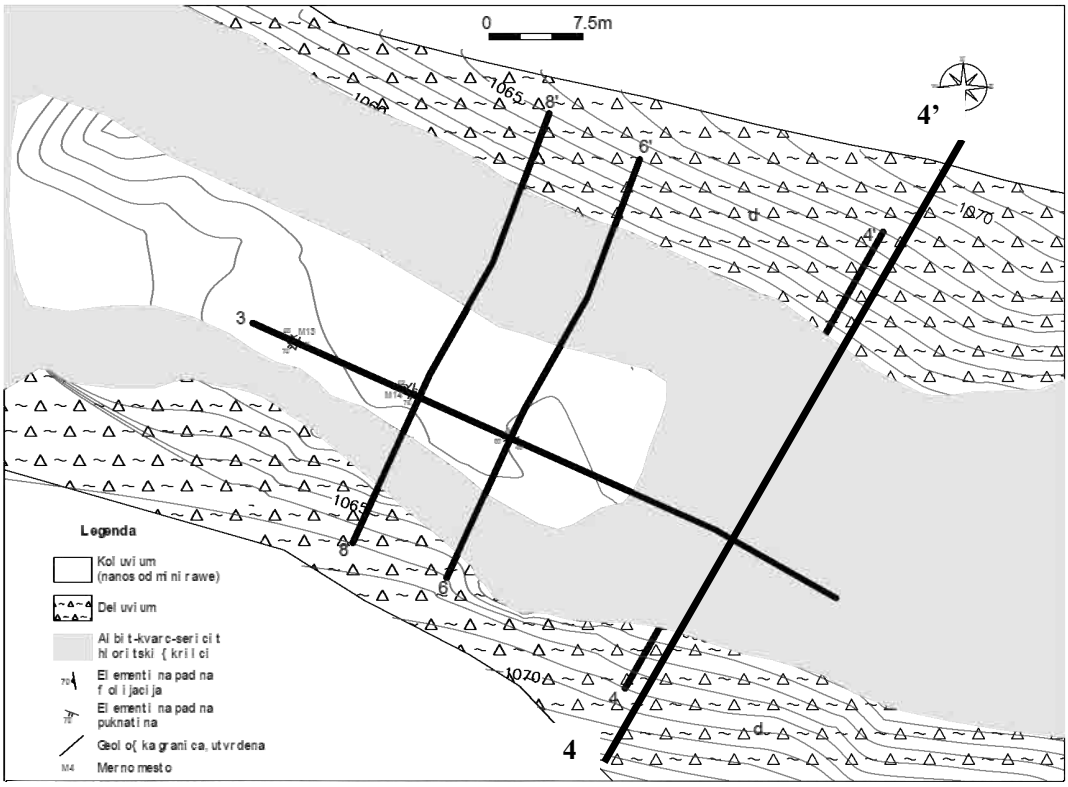
APPENDIX 1



Engineering and geological map of the Investigation area