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Exploitation technology of Limestones in Seqishtë-Hani iElezit-Transportation Road Construction

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Abstract: The intent of this research paper is to outline two aspects of limestone exploitation in an open pit mine operation. The first aspect is design optimization of the safety benches in a surface quarrying. The second one is the essential problem in constructing such amine is drafting the layout of the road for the limestone transportation. To ensure the stability and safety of the working benches as well as extraction and transportation equipment the serpentine shaped paths were chosen and constructed as the most favourable for this particular type of mine operations, researched in this paper.

***Keywords**: Limestone, quarry, road construction, transportation equipment*

Introduction

Physical - Geographic Features

The mapped area is situated in the southern part of Kosovo, about 3 km southwest of Hani iElezit,and falls under the jurisdiction of the new municipality of Hani iElezit. The area is bounded by the Republic of Macedonia on the south and with Kaçaniku municipality on the north (Figure1).

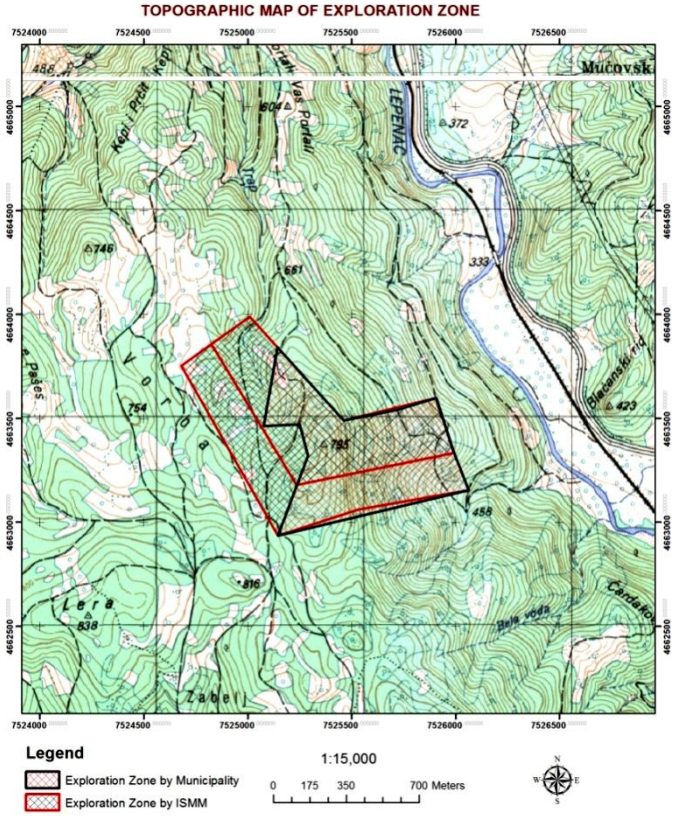

Figure1. Topographic map of exploration zone

Exploration area lies on the western side of Prishtina-Skopje motorway.Our detailed research has included the area bounded with Kosova REF 01 coordinates, Seqishte locality in the municipality of

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Hani iElezit.The terrain morphology is typically mountainous – hills and mounts. The explored area was carried out in the eastern parts of the Sharr Mountains, with highest peaks; Ivajëand Seqisht (975m).The narrow strip of limestone deposit in our study is Seqishte area which is situated in Kaçaniku valley on the right hand side of the river Lepenc (Fejza & Sahiti, 2014).

Geological Setting

In the geological structure of the explored area are evidenced: Crystalline basement, serpentinite, Cretaceous sediments

Crystalline basement (biotite – muscovite schist) (Pz). Composed from amphibolites, quartz-sericitic schists, marbles, and sericitic schist of Permian – Triassic age.

Ophiolites of Jurassic age are represented from tectonic lenses of mantel peridotites, intensively serpentinised represented by harzburgites with some dunitic lenses, from the obduction phase over the continental platformic of Korabi in west, or over the western marginal of Rodopes in the east.

Harzburgitespresent a porphyroclasticfacies up to milonitic, of low temperatures characteristic of basaltic peridotites of Lithospheric deformation during the inter-oceanic mount forming phase, which continue with the obduction of oceanic lithosphere over marginal continent. The Harzburgites are extremely serpentinised. The serpentinization process is related with the tectonic settings and the exposure in the surface of continental deep mantel peridotites.

Serpentinite($J_{2\text{-}3}$)-are followed by the ophiolite Vardar zone NNW- SSE

Cretaceous sediments ($K_2^{2\text{-}3}$)are represented mainly by flysch and limestones.

Flysch sediments are located onto the limestone. This package of rocks is built from, sand, marls and limestone in combination with thin layers of limestone.

Cretaceous sediments are located transgressively over crystalline basement and serpentinites. The age is Barremian-Aptian. The deposits are predominated by limestone of the paloidalpackstone-grainstone interrupted from very thin calcite dikes. Microfossils are rare, such as: *Orbitolina*sp, *Sabaudia*sp, which belong to the Lower Cretaceous (Barremian-Aptian age).

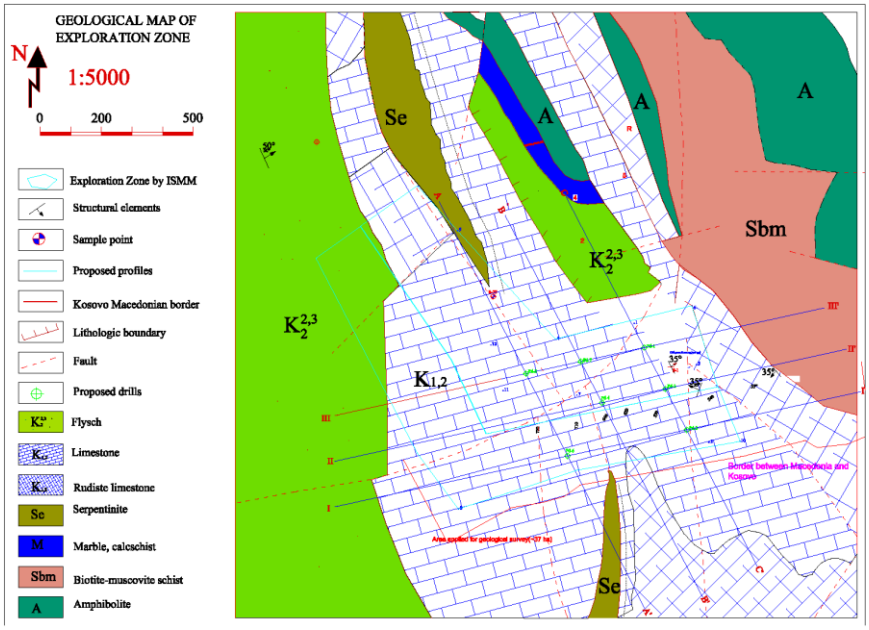

Figure2. Geological map of exploration zone –Seqishte area. Hani iElezit

Opening the Mine

Once the layout of the exploitation area has been established, another essential planning duty is determining the course and intensity of the works in limestone exploitation. For severely steeped deposits, the intensity of the work done and the depth of the bench are the main limiting factor which dictates the capacity of the exploitation of the quarry. In the opening of the open pit mine, the Contour or Bench method of surface or strip-mining is chosen to ensure the safety and security of transport lines incoming from working benches with the aid of respective mining works. The opening

begins in bench +710 and so on until the last bench +500. If the dynamics of the production demand, the exploitation could be done simultaneously in two benches (for example +710 and +700) (N. Krasniqi, 2014) Initially, the road (path) is constructed according to sanctioned parameters with a 10-12% slope, width of 7 meters and a specific sanctioned radius on curvatures of the road for trucks. The path continues on until the opening spot at bench +710.

Determination of Benches-Exploitation System

A characteristic of the exploitation system of deposits, where the mineral (stone) strip is steep or severely steep, is that the span of the operational zone is quite restricted due to the depth of the final level of the quarry.

Studying the prospective exploitation system of this mine, we have concluded that only viable form of transport is by truck. (Krasniqi, 2014)

Components of this system are:

- exploitation of inverse shovel excavators and transportation by truck
- exploitation of loading bucket truck type Fiat Hitachi
- Bench height 10m
- Transportation road (path) with a width of 7m,10-12% slope

Preparation sand the dynamics of the work in progress are aligned to the capacity of the chosen equipment and the yearly productivity. The process of the stratification of the mine as a function of the height is conditioned by the morphology of the terrain.

From previous surface exploitation practices, bench height is assigned based on the physio-mechanical components of limestone and parameters of the equipment in use. Multi-bench slopes in hard rock quarries where the individual bench heights and the overall slope height are themselves significant in realization of the planned production.

Apart from these principal areas, other external factors may also influence the stability of excavated slopes, such as loading by spoil and machinery, vibrations due to blasting, processing or earthquakes and the effect on slope and rock mass geometry by other engineering activities (GWP Consultants). Overall mine slope and bench slope stability is one of the most important issues in the execution of the operations. The adoption of incline slope angles in the most realistic way shows a higher safety degree during the exploitation process. Based on the defined area of exploitation and technological parameters of the quarry such as:

- Bench height, h
- Quarry height, H
- Incline of working slope angle, β
- Final slope stability angle, α
- The width of the safety platformb

the final contour of the quarry has been constructed.

The quarry will be exploited with a bench height of 10[m]. Working benches on phase one; +710, +700 +690, +680, +670, +660, +650, +640, +630, +620, +610 and all of them the inclined land type.

Bench Height

Determination of bench hight hinges on the physico-mechanical properties of the exploitation site and on the mecanism that will be used and which ensures safety at the worksite. The height of 10 m for the bench has been sanctioned.(N. Krasniqi,2014)

Verification of the bench height is conducted with this formula;

$$h = \frac{X^2 \times \sin\alpha \times \sin\beta}{2 \times K_{sh} \times W \times \sin(\alpha - \beta)}$$

Where:

h –Bench height

X – Average width of the exploited mineral which has also been sanctioned X=15[m]

α- Bench angle $\alpha=70^0$

ß –Exploited quantity angle ß = 40^0

K_{sh}-Loaminess coeficient that according to literature in our case is 1.4

W-least resistance line based on calculations W= 3 m

$$h = \frac{15^2 \times \sin 70° \times \sin 40°}{2 \times 1.4 \times 3 \times \sin(70° - 40°)}$$

$$h = 24.25[m]$$

For safety purposes we have sanctioned a height of h=10[m], however physio-mechanical and technical properties of the cliff allow us to form benches with a height up to 24.25[m].

Working Bench Angle And Final Slope Angle

The working bench angle has been sanctioned based on experience so far in surface mining and lab analysis and is determined to be $\alpha = 70^0$, meanwhile the final slope angle based on the geometry acquired is $\beta = 45^0$ (fig 1)

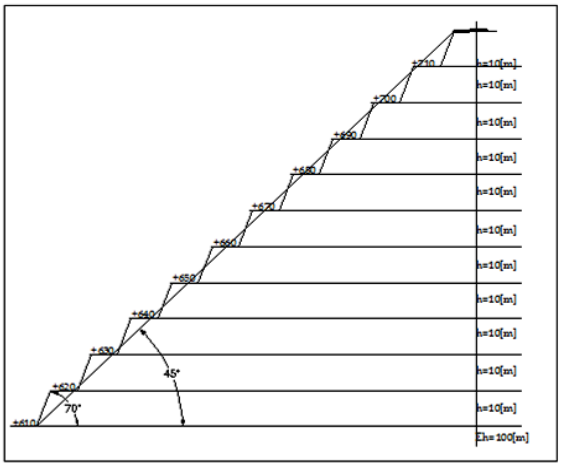

Figure3. Bench slope angle and final slope angle

Final slope in surface mines represents a plane (line) drawn in the edges of the working benches, and is calculated with this formula:

$$tg\beta = \frac{\Sigma h}{\left(\Sigma h \times \cot\alpha + \Sigma b'\right)} = \frac{100}{\left(100 \times 0.364 + 70\right)} = 0.93$$

$$\underline{\beta = 43^0}$$

Where:

b' – width of the finalized bench (10 x 7 = 70[m])
h – bench height 10[m]
α – working bench slope angle 70^o

Opening option – road (path) construction

For the proposed variant the depth of the quarry is built with the quota (+710-+500) the opening is proposed to be from up-down. (N. Popovic, 1969)
Characteristics of this veriant are:

- bench heigh 10[m]
- transport by truck
- opening of benches of the inclien and declining type with bench tranches

Serpentine Road

Construction of such roads includes its length only within the exploitation site, begining from the first bench +710 and ending at the final bench +560 on the north side of the site – the model used as seen in Figure 4 (Popovic, 1969; Živković, *et al*., 2002). Up to level +510 the benches are the inclining type meanwhile benches +510; +500 are the declining type. Road construction has been done according to the planned level with a slope 10-12%.

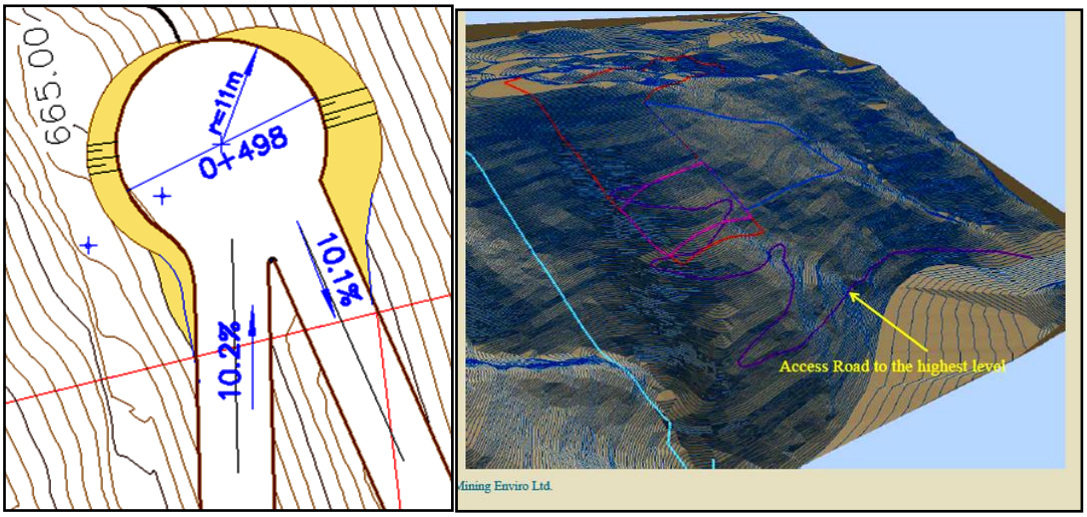

Figure 4. Road layout curve

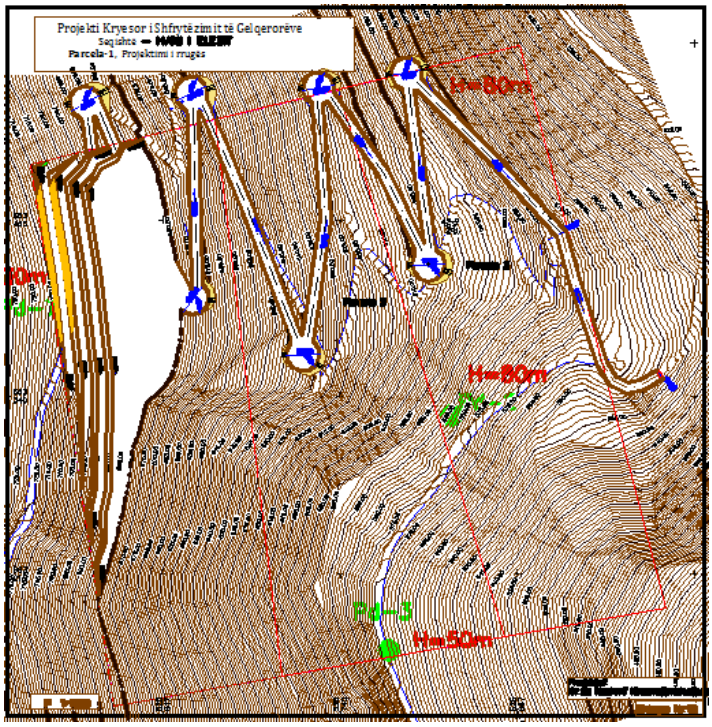

Figure 5. Building working benchesand trasportation road

Table 1. Road elements

Nr	Starting and ending point of a road segment	Length L [m]	Qouta	Interchanges Δh [m]	Slope i [%]
1	0+000 - 0+191	L=191	710 - 690	Δh=20	10.4
2	0+191 – 0+352	L=161	690 - 675	Δh=15	9.3
3	0+352 – 0+498	L=146	675 - 660	Δh=15	10.2
4	0+489 – 0+695	L=197	660 - 640	Δh=20	10.1
5	0+695 – 0+887	L=192	640 - 620	Δh=20	10.4
6	0+887 – 1+044	L=157	620 - 605	Δh=15	9.5
7	1+044 – 1+184	L=140	605 - 590	Δh=15	10.7
8	1+184 – 1+337	L=153	590 - 575	Δh=15	9.8
9	1+337 – 1+483	L=146	575 – 560	Δh=15	10.2

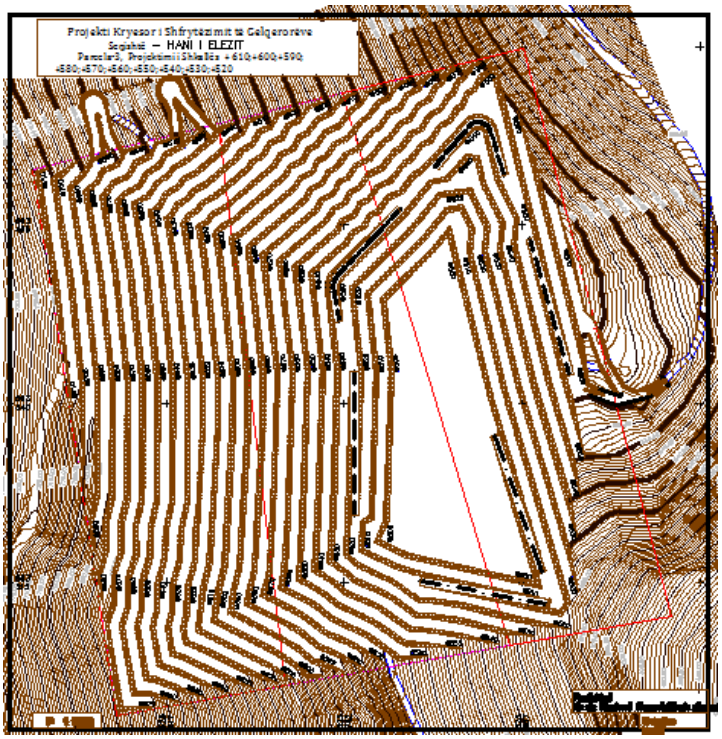

Figure 6. Final state of working benches and transportation road

Conclusion

Comparing the shape and position of the road as well as the mass that need to be scooped out to build the road, we can come to a conclusion that the serpentine shaped path is quite favorable for limestone quarry exploitation. The serpentine path has a leng of L=1483[m] only withing the exploitation site with an average slope of 10.06[%]. The quantity of the mass that needs to be scooped out from level +650 up to +710 is a total of V=6674[m³] limestone quantities.From this data, we can come to a conclusion that a favorable shape of the path based on floor, length and quantity of the material enables a quick contruction of the road and stability for the duration of the exploitation of all limestone reserves.

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