

## 3D STRUCTURAL MODELING AND ORGANIZATION OF SILICATE DEPOSIT OF Fe, Ni IN GLLAVICA

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### ABSTRACT

*Deposit of Fe, Ni-silicate in Gllavica in terms of geographical position is located 20 km south-west of Prishtina in the south east near Ultrabasic Massif of Golesh. The essence of the study is (3D) modeling of structures, textures of ore bodies and deposit in entirety by organizing database system during the research process on iron and nickel in Gllavica deposit in 2007. Potential of research is the geological system automation and organization of database of Fe, Ni deposit in Gllavica, through which 3D geological models are textured: litholo-strata-graphic structures deposit, ore bodies structures composed of ore bodies elements, the position of Ni distribution, in relation to spatial position of deposit, which in the end resulted in the conclusions on the factors that led to the formation of Ni-silicate deposit in Gllavica and other geological factors in the formation of the crust breaking. (3D) modeling structure in perspective of the field of research has shed light on the spatial position of the ore body on Fe and Ni, breaking crust spatial position in relation to the Golesh massif giving potential directions of continuity of the ore zone related to the breaking crust.*

**Keywords:** 3D Modeling. Structure, texture, ore bodies

### 1. INTRODUCTION

Recently in the world it is the trend of sophisticated computer applications development of deposits geological data base system which enables designing of three-dimensional geological models in the intensified research areas for deposits of useful minerals and other geological issues.

The development of such applications enables organization of geological data base which somehow facilitate: Quick access to information, development of plans, maps, 3D models, which allow analysis and fair judgment of professional and scientific opinion on the position and conditions of the geological formation (Ballhaus et al., 1994).

Our research consist of such organization through computer applications, including 3D Geological mapping, cross sections, 3D block diagrams, and geostatistical analyses presented in diagrams that explain the natural pattern of the Ni distribution, define the textures, structures

formation of ore bodies and designing 3D geological deposit of Fe, Ni in Gllavica.

### 2. GEOLOGY OF GOLESH AREA

Wide area of Golesh massif takes part in the geotectonic rock-forming area of Vardar which consists of peridotite and the remnant of the crust breaking peridotite with relatively small area (Fejza et al., 2010). Peridotite of this area form the massif of "Golesh" and mineral composition consist of orthopyroxene and clinopyroxene, while the age of the peridotite is defined as Upper Jurassic. Harzburgite and dunite cover central part of the massif.

Dunites- occur in the south-west of the massif, near the settlement of Medvec and Vrella and rock consist of hypidiomorphic granular texture. Serpentinite are found in suburb areas of the massif and the process of intensely serpentinization of peridotite is located near the floor of the massif (Campbell et al., 1979). The serpentinization process represents more pervasive and fundamental

process of auto-morph transformations and consist of serpentine mineral, iron oxides, silicate oxides, magnesium oxides, etc (Leshner and Groves 1986). The serpentinization process and breaking crust which appears mineral bodies Fe, Ni-Silicate, Cobalt have been developed in Gllavica locality (Fejza et al., 2013).

Research has found crust breaking in a vertical line and other linear forms of alienation which go down to 200 m depth, up to 390 m quota. Three-dimensional relief model shows geological structure of Golesh region and spatial perspective of mineral areas of the crust breaking and other mineral bodies. Series of Paleozoic rocks which represent Golesh massif show that these rocks have fall under ultrabasic massif of Golesh.

Massif does not reflect the movement in entirety, but cleavage towards the center of the massif is seen in the margins on the outskirts (Meshi et al., 2006). From a regional perspective the massif represents a horst, which is due to deployments and deep tectonic break toward Risinoc-Poklek and Magura-Bardh i Madh (Figure 1).

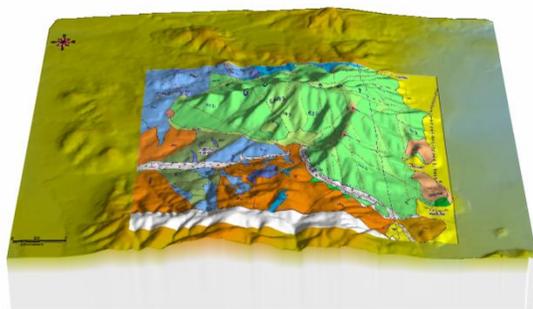


Figure 1: 3D relief model and geology of the massif of Golesh 1:25000.

The structural profile shows that Paleozoic formations in the northern and southern parts are inserted under massif of Golesh and Ni deposit in Gllavica. (Peci, 2003). In this case, there are observed tectonic fractures expressed in deployments that have indirect directions from each other (Figure 2).

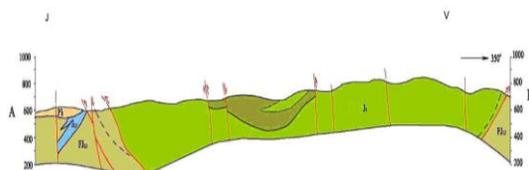


Figure 2: Structural profile of the massif of Golesh 1:25000

## 2.1. Geological structure of Fe, Ni-silicate deposit in Gllavica

Research process on Fe, and Ni, in Gllavica location is intensified in 2007, and a total of 197 drillings of 50 x50 m density have been completed within an area of 100 ha. Research took place through core drilling. Results have shown that out of 197 drillings, 194 gave a positive result with Fe and Ni. Conducting the research by applying method of drilling, geodetic survey (record) of the area as well as other forms of research, it was organized data base system of Fe, Ni and silicate deposit of Gllavica.

3D model of deposit and geological texture of Fe and Ni deposit was designed by applying the methodology of integrated interpolation of data processing (Figure 3). Database organization of Fe and Ni deposit and analysis of 3D model, starting from the top to the bottom of the deposit is composed by the following formations: Humus clay, Sandy and gravel clay, Sandy clay, Sand, Gravel, Iron nontronite hydroxide, Opal Zone, Iron hydroxide area, Nontronite area, Alternated serpentines area, Compact serpentines area, Schist area. Eastern and south-western part of the deposit is structured with Pliocene sediments and Paleozoic formations that constitute basement of Fe and Ni deposit. Pliocene sediments are deposited in the Kosovo Basin and appear sandy-clay, clay, sandstone, gravel, sandstone terraces form. It is shown that the erosion of broken crust has occurred before tertiary sediment deposits.

The time of the formation of floor by serpentized magnesium breccia that are found in these sediments, has occurred after the deposition, or intensive erosion of tertiary sediment and rising of terrain. It is difficult to determine the age of this geological formation. It is certain that it is newer than the increase of peridotite on the surface, from the Jurassic and older than Miocene. We believe that the formation of the crust breaking belongs to the period between the Cretaceous and Pliocene.

For the formation of these ores in the beginning has been serving the transportation of the crust breaking materials and their re-deposits not far from the dramatic cliffs (Tmava et al., 2013). So

full profile of ore body closes inside serpentinite and clay deposits which is defined lower limit of the alienation zone. Breaking crust formation is a consequence of regrouping of minerals from the rock mass chemically unstable in thermodynamic conditions of the earth surface.

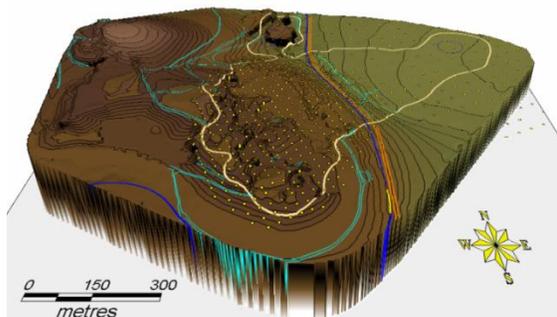


Figure 3. Relief model of Fe and Ni deposit – Gllavica

### 3. EXPERIMENTAL DATA AND METHODOLOGY OF STUDY

The database contains thousands data on the main base metal contents which are found to be present in the Ni deposit of Gllavica, ultrabasic massif of Goleshi. For the scope of this study, only data on Ni contents are considered and elaborated in order to determine the quality of the ore and assist in resolving issues of Fe and Ni distribution. Data processing methodology for the modeling of Ni rich areas is performed by using the Software Rock Ware which starting with the spatial database from the drillings and chemical analyses and applying integrated interpolation in nickel-rich areas gives the most rich areas in Ni. (Table 1).

The Stan Terg is located in the north part of Mitrovica city (Kosovo), the geographic position is between the north latitude 42° 52' 30" and east longitude 20° 55' 0". Mining activities and smelting of the silver bearing lead-zinc ore in Kosovo has a long history and can be dated back to even pre-Roman times as the relics of tools and diggings show. The Stan Terg mine is located in the north part of Kosovo; about 800m above sea level and 11km from the near town of Mitrovica. Modern mining began in 1930 at the Stan Terg lead-zinc mine, which is located on the Trepca stream.

Table 1. Database system

Name	Location	Orientation	Lithology	Stratigraphy	Intervals (I-Data)	Points (P-Data)	Fractures	Water Levels	Symbol
SH-1111T									
SH-1111V									
SH-1111X									
SH-1111Z									
SH-1152O									
SH-1152P									
SH-1152H									
SH-1152U									
SH-1152L									
SH-1152N									
SH-1152P									
SH-1152R									
SH-1152T									
SH-1152V									
SH-1201									
SH-1203									

In the figure 4 below, is shown the degree of concentration of Ni to nickel formations on the vertical column of the drilling which are then used for the construction of the qualitative model of the deposit as a whole

#### 3.1. 2-D and 3-D spatial modeling of the qualitative data

Main parameter that affects categorization of useful mineral deposits is their qualitative composition and form of the distribution of useful component in ore body. In practice, changing the properties of the ore bodies is expressed by a variation coefficient.

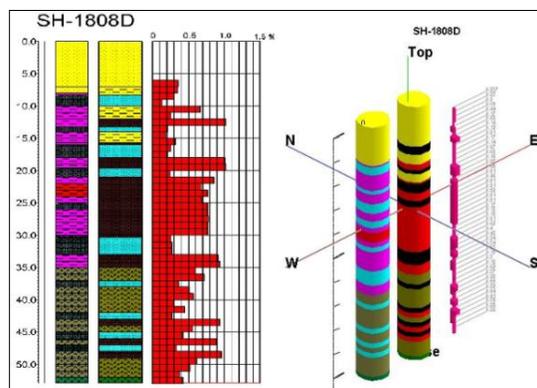


Figure 4. Modeling of research drilling

This coefficient expresses the ratio between average quadratic deviation of a property of an ore body and the arithmetic average of this property subject to the study. For distribution statistical process of variable is obtained parameter of Ni with 0.5% minimum coefficient. As the calculation of variation coefficient is based on 241 samples from 30 research drilling.

$$K_v = \frac{D_{(m)}}{M_{mes}} * 100 \%$$

In the case of Fe and Ni deposit in Gllavica have been obtained evidence of medium weighted values

and have resulted average composition of Ni (30 drilling).

$$M_{me} = \frac{\sum M}{n} = \frac{183.307}{238} = 0.77\% \text{ Ni}$$

$$M_{mes} = 0.77\% \text{ Ni}$$

Average quadratic deviation of Ni components is:

$$D_{(Ni)} = \sqrt{\frac{\sum (M - M_{mes})^2}{n-1}} = \sqrt{\frac{27.352}{237}} = 0.3397\% \text{ Ni}$$

Variation coefficient is expressed:

$$K_v = \frac{D_{(m)}}{M_{mes}} * 100 = \frac{0.3397}{0.77} * 100 = 43.37\%$$

Simple series variance is calculated according to the formula:

$$\delta^2 = \sum \frac{(M - M_{mes})^2}{n} = \frac{27.352}{238} = 0.1149$$

Range 1.76, Median of series of numbers is 119-120, Median value is Me=0.656-0.66 % Ni Average content error.

$$G_{me} = \frac{D_{(mes)}}{n} * 100 = \frac{0.3397}{238} = 0.00142$$

These data are processed and indicated in cumulative histogram (Figure 5).

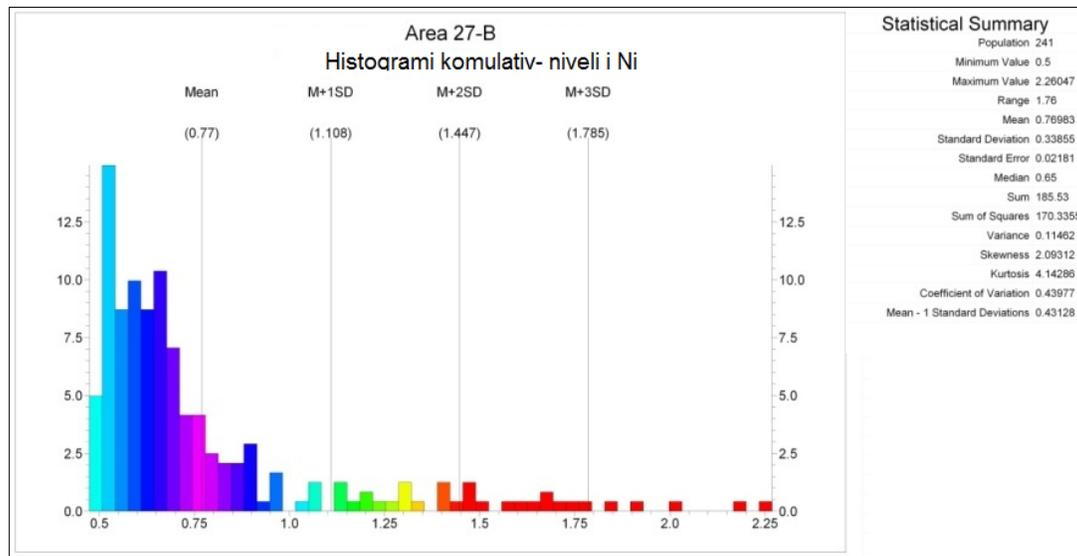


Figure 5. Cumulative histogram on nickel distribution in 30 drilling

Average content error is directly proportional to the average quadratic deviation while indirectly proportional to square root to the number of tests. Based on this and the variation coefficient according to authors: Krasnjikov and Barishev, Ni deposits are categorized into five main groups. Thus we conclude that the Ni component distribution with variation coefficient Cv=0.43 fall under the third group category with uneven distribution of Ni component. Ni average value was interpolated from average value of drilling researches (Figure 6).

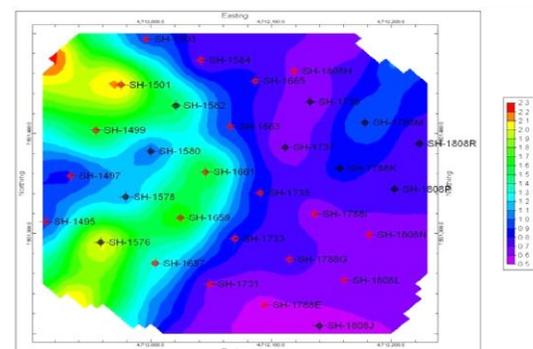


Figure 6. Interpolation of the Ni distribution in 30 drilling.

Cross profiles have been modeled in order to explain in detail the conclusion of zonality and properties of Ni distribution from the database system of deposit. The data have been processed

in cross-profile by the method of interpolation, the approximate values of Ni, in an integrated way and thus is achieved the concentration level and other forms of Ni distribution (Figure 7).

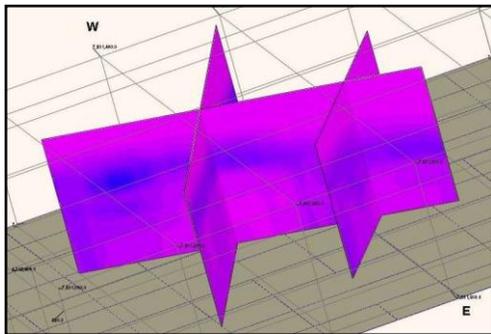


Figure 7. Cross profiles

In cross profiles, the conclusion is that the interpolation of the Ni concentration has uneven distribution and zonality of distribution varies depending on the formations that make up the ore body. Expounder of cross profiles shows Ni concentration level, while green color indicates the highest level of Ni concentration up to 2.78% (Figure 8).

For further clarification on the analysis of the deposit geologic texture, form and manner of the extent of formations in relation to ore bodies which constitute the deposit by organized system of the database applying the method of integrated processing interpolation, is gained (3D) model of the drilling and the (3D) model of the ore body.

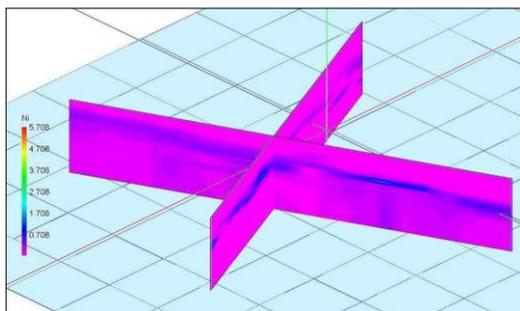


Figure 8. Cross profiles

This led to the conclusion of formations which constitute the ore body with Ni concentrations. So formations which constitute the ore body are: iron hydroxide with nontronite, iron hydroxide, nontronitized clay, nontronitized serpentinite which form horizontal and subhorizontale configuration to the lower limit of serpentinite alienation and Paleozoic schist (Figure 9).

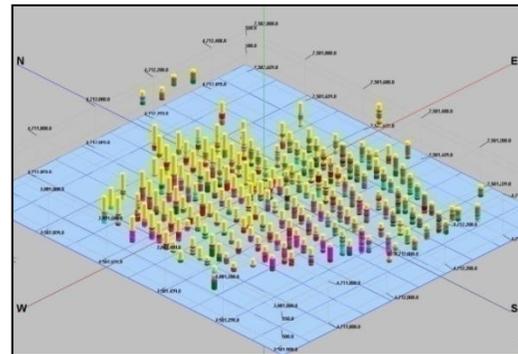


Figure 9. Three-dimensional (3D) drilling model.

From the analysis of geological deposit formation factors, factors affecting the regrouping of Ni mineralization, form of configuration and composition of the formations which constitute the ore bodies, the shape of the distribution of Ni concentration, and other forms of linear expansion of the ore body in ratio to geological formations, we draw the conclusion that the ore body is formed in equilibrium conditions of calm waters in a colloidal environment isolated from the Pliocene formations after intensive erosion of breaking crust by chemically unstable rocks in the earth's surface thermodynamic conditions

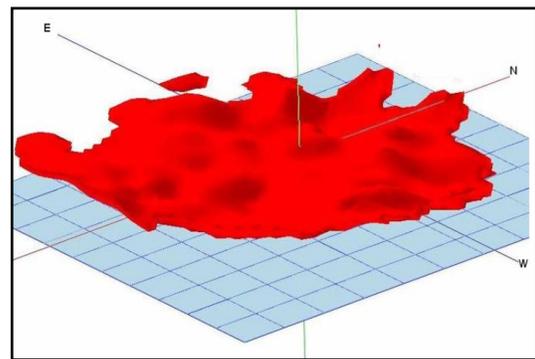


Figure 10. Three-dimensional (3D) model of the ore body

When analyzing Ni concentration areas and (3D) model, it is observed a zonal division into two parts, the southern and northern part of the deposit. In this we have judged that the main factor influencing zonal division of Ni concentration into two parts is that the water flowing through water flow of Medvec, crosses through the middle of the Ni deposit, which during high intensity water flow somehow has led to the disintegration of Ni element, and other

supporting elements, or the displacement of useful elements in the rest of the basin (Figure 10).

From (3D) model of block diagram of deposit in Gllavica, we conclude that the morphology of ore bodies is composite layered character with horizontal zonality (Figure 11).

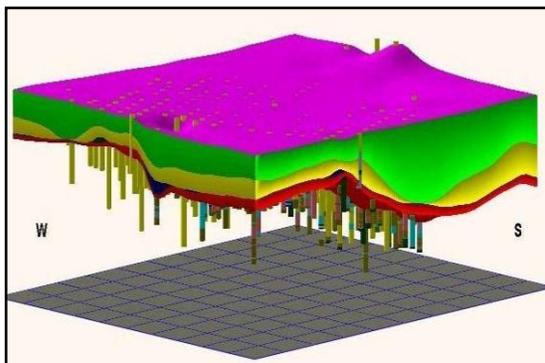


Figure 11. (3D) Block diagram of Ni deposit in Gllavica

#### 4. CONCLUSIONS

Nickel ore is formed under specific circumstances of chemical destruction processes of serpentinized peridotite which conditioned vertical zoning of nickel, iron and other supporting elements in deposit profile. In this field the Ni ore is concentrated in different conditions of concentration distribution.

Factors that have contributed to the re-grouping of chemical elements and the formation of new minerals are chemically unstable rocks in the earth's surface thermodynamic conditions and Pliocene formations which have served as a shield in the preservation of the concentration of Ni and other supporting elements.

Based on the distribution of Ni useful component with variation coefficient  $C_v=43$ , we conclude that the deposit is classified in the third group with uneven distribution.

According to the (3D) model of the ore body and rich of minerals areas, ore bodies' morphology consists of layered composition character with horizontal zonality.

Main factor that has led to the separation of Ni concentration in two parts is that the waters that flow through Medvec water flow, crosses through the middle of Ni deposit, which in the course with high intensity somehow has led to the disintegration of Ni element, and other

supporting elements, or the displacement of useful elements in the rest of the basin.

Descriptive statistics of all the parameter's understudy revealed that the main water quality pollution in the studied area can be attributed mainly to the mineralization of the area and discharged water from the mining operation. Principal component analysis and factor analysis was proven as a feasible technique in source's apportionment: it is a useful method that could assist decision makers in determining the extent of pollution via practical pollution indicators. Correlation matrix, together with other multivariate analyses, seems to point towards a common source for heavy metals.

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