5th JUBILEE BALKAN MINING CONGRESS

PROCEEDINGS

18th-21st September 2013 Ohrid, Macedonia

ELEM
MACEDONIAN POWER PLANTS

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BALKANMINE 2013

Ohrid, Republic of Macedonia

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Track-type loader excavator at work
- Dmitry Kalinovsky
Miner in a pit
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APPLYING GEOMAGNETIC RESEARCH METHOD IN ALLUVIAL DEPOSITS OF GOLD

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ABSTRACT

Republic of Macedonia, according to current knowledge, have alluvial deposits of gold that were exploited in the past, unfortunately, long time was not addressed on this tip of deposits. Existence of contemporary geophysical methods, especially high precision magnetometers, gives relatively easy and very efficient possibility for defining the area of alluvial terraces, not only on the existing rivers but, also, in the old riverbed.

To define the most prospective areas for detailed research, bearing in mind that the gold and accompanying heavy precious metals are non-magnetic, which are of exploitation interest, almost always, paragenetic, magnetite is present with them. Magnetite as a mineral have the highest magnetic level, according to that is easy detectable.

Department of geology and geophysics owns appropriate equipment for geomagnetic profiling and software for analyses of measured data. Areas with registered anomalies should be investigated with schlich method and core drilling in order to define depth of alluvium.

Keywords

Alluvial Deposits, Geomagnetic Methods, Gold

1. INTRODUCTION

Geomagnetic method is based on measurements of the geomagnetic field elements on an area. Generally, geomagnetic field can be divided in two components:

- Anomalous geomagnetic component that reflects the influence of rock masses on the investigation area, and
- Component that origin from the normal geomagnetic field generated in the Earth's core.

Anomalous component of the geomagnetic field consists of regional part that reflects deep seated magnetic structures and which influence covers larger area; and local anomalous component that is generated from factors which are seated in the shallow part under the Earth's surface and their influence is feel on a small area.

In exploration of mineral raw materials is essential to separate regional from local component, because the local anomalous component of the field is directly connected with the mineral raw material.

The depth to which geophysical measurements can be conducted in exploration of ore deposits is defined with the dimensions and shape of the ore body and measurable differences in the physical properties between the ore and the surrounding rocks. Generally, it can be concluded that for the need of mining, geophysical explorations can be conducted to depth of about 120 m.

2. SELECTION OF EXPLORATION METHOD FOR CERTAIN GEOLOGICAL PROBLEM

Selection of geophysical method for exploration of mineral raw material depends of several factors:

- Existing geological data (level of geological explorations);
- Type of mineral raw material;
- Topography of investigation area;
- Possibility for solving the problem with appropriate geophysical method;

- Economic justification of the geophysical method etc.

Special success in ore regions has application of geomagnetic and geoelectrical method.

Magnetic anomalies caused on the earth's surface from the given ore bodies or structures depend on:

- Difference between the magnetic susceptibility of the ore body or structure and surrounding rock masses;
- Dimensions, shape and orientation of the ore body or structure and
- Depth of the ore body or structure.

Geomagnetic methods, in their recent application, gave good results in exploration of mineral raw materials, especially in iron ores. From prospection point of view, they are applied for limitation of areas with magnetic rocks which contain increased amount of magnetic minerals (magnetite).

It should be known that gold is not magnetic, so the geomagnetic method is not suitable for its direct exploration. Investigation of gold - bearing deposits (secondary deposits) is possible with the geomagnetic method only indirectly, knowing that the area of gold deposition is the same with the heavy mineral facies. Here is interesting magnetite which gives clear local magnetic anomalies.

3. DETAILED GEOMAGNETIC PROSPECTION

To define the geomagnetic prospection of the alluvium in Lakavica ridge, terrestrial measurements of total magnetic field vector were performed (scalar F value). Measurements were made with proton magnetometers type:

- Bison model MMP-203-M3;
- Bison model MMP-203-M4 and
- Portable Magnetometer Geometrics.

Figure 1 shows anomalous values of the magnetic field from factors that are seated on different depth or magnetic field $\triangle T$ gives summary for the investigated area. With aim to separate the reasons for magnetic anomalies that have local and regional significance, filtering of the values for $\triangle T$ was performed:

$\triangle T = \triangle T_R + \triangle T_L$

where:

$\triangle T$ - total anomaly

$\triangle T_R$ - regional anomalies

$\triangle T_L$ - local anomalies

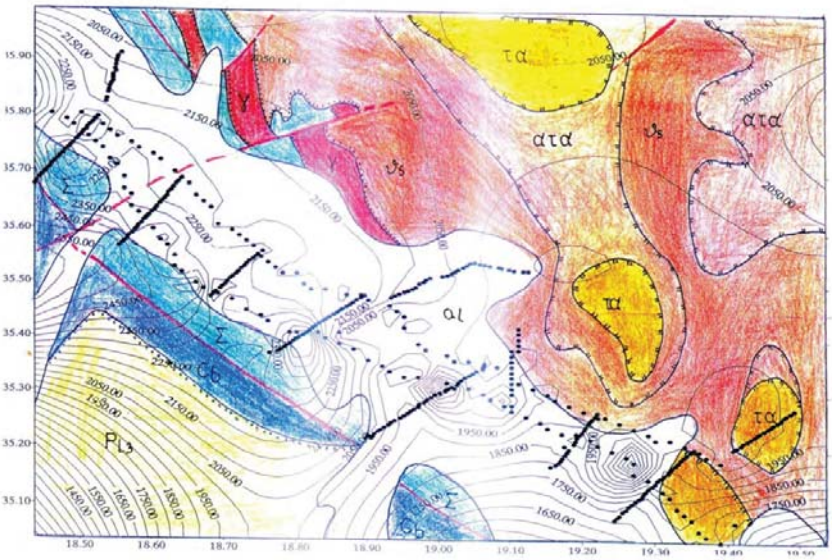

Figure 1. Map of total magnetic field vector on Borov Dol

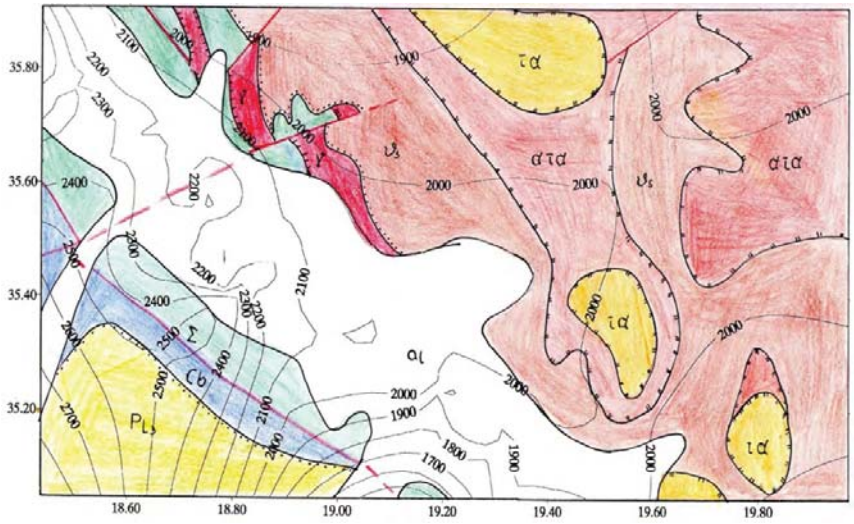

Figure 2. Map of regional geomagnetic anomalies on Borov Dol

Method of linear regression analysis was used. For this purpose is used Excel program. With these methods, total value of $\triangle T$ is divided on regional $\triangle T_R$ - values from the linear part and values of $\triangle T_L$ - residues between the linear curve and results for $\triangle T$. These results are shown on figures 2 and 3. Method of linear regression analysis is a method which is combined with the recent knowledge for explored area. Linear regression analysis along the measured profiles was performed in a way of searching linear dependence of the profiles, separate for each of them from the edge of the depression toward its axes.

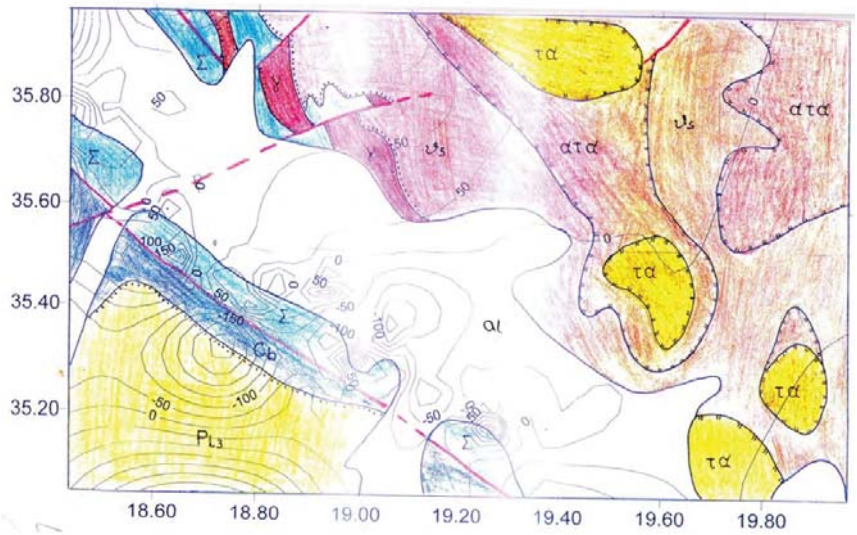

Figure 3. Map of local geomagnetic anomalies on Borov Dol

Comparing the obtained maps for $\triangle T_R$ and $\triangle T_L$, with the regression analysis method, it can be seen their compatibility in definition of local and regional anomalous values.

4. ANALYSIS AND INTERPRETATION

Analysis of the map of total magnetic field intensity value, $\triangle T$ (fig. 1) gives possibility for defining the areas with larger or smaller magnetism. Map of the processed data gives values in range of 1700 to 2700 [nT]. For that reason were made above mentioned analyses, to obtain clearer picture for existing anomalies in the Lakavica ridge.

Map of regional anomalies $\triangle T_R$ of the Lakavica depression (fig. 2) shows the influence of magnetic reasons which are deep seated in the Lakavica depression and their influence is felt on a larger area than the explored terrain. In this case, those are reasons which are on larger depth than the depth of the depression. In analysis of the map of the regional anomalies in the Lakavica depression is notable that the intensity of the magnetic field decreases from the Damjan hors towards the center of the depression and increases rapidly from the center toward the Serta horst.

Map of the local anomalies of the Lakavica depression $\triangle T_L$ shows existing of the magnetic structures on maximal depth of 130 m which are clearly shown on the map. In analysis of the map of local anomalies (fig. 3 and 4) clearly are separated positive and negative anomalies, especially in the area of the locality Borov Dol where is present dipole anomaly with positive picks of 350 nT and negative of -300 nT.

According the selected local anomalies, their depth was calculated with the formula:

$$T = \frac{M}{z^2}$$

where:

T - intensity of the local anomaly;

M - magnetic moment of the local anomaly;

z - depth of the geological structure.

The dipole anomaly present on the profile I - I' (fig. 4) with orientation NE - SW, shows positive and negative values of geomagnetic dipole of about -50 to +50 nT, where the positive part is seated on depth of about 30 m, and the nagetive part is on 60 m. Geomagnetic dipole II - II' shows positive and negative local anomaly with values from +150 to -130 nT, depth of the positive part of 40 m, and on the negative part 30 m. This dipole is with orientation NE - SW. Geomagnetic dipole III - III' has orientation SW - NE with positive and negative values form +250 to -200 nT and the same depth of 40 m. Dipole anomaly on the profile IV - IV' shows dipole factore for magnetic anomalies on depth of about 80 m and values for the positive and the negative part of +350 to -100 nT.

On the map of local anomalies of Borov Dol are present two monopole geomagnetic anomalies. Negative local anomaly 1 - 1' is characterized with magnetic reason of -300 nT on depth of 130 m. Anomaly marked as profile 2 - 2' gives positive local anomaly with value of +250 nT which is on the depth of 60 m.

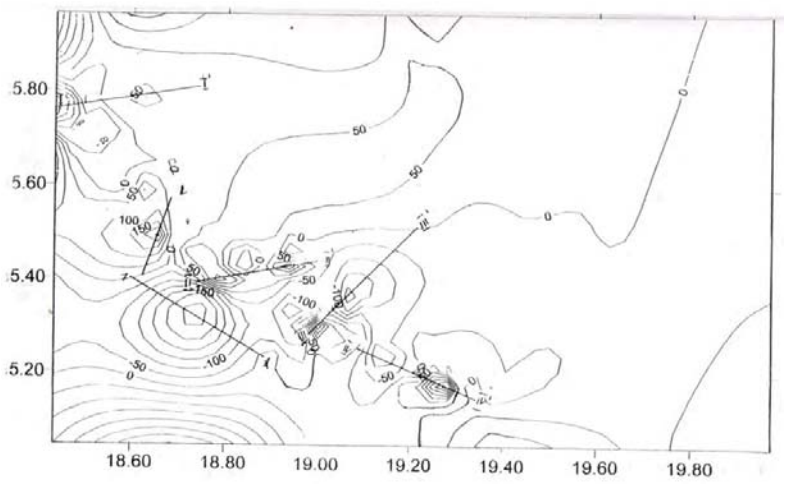

Figure 4. Map of local anomalies with profile for calculation the depths of the Lakavica depression

5. CONCLUSION

The purpose of these investigations is alluvium in the part of the Lakavica ridge, from the point aspect of concentration of magnetic minerals.

Geomagnetic prospection gives possibility for separation of the most perspective areas from the point of view of this method.

Local magnetic anomalies show areas in the alluvium with increased concentration of magnetic minerals (magnetite).

Knowing the physical properties of the magnetite (its density) and recent global experiences for the alluvial deposits, it is possible in the areas with increased concentration of magnetite to be expected presence of other native metals and minerals (gold, platinum, etc.).

If there are no presence of metals and minerals of interest in the area of detected magnetic anomalies, it can be concluded that they are not present in whole area and further investigation are not necessary.

If analyses show presence of useful mineral raw materials, further explorations are necessary.

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