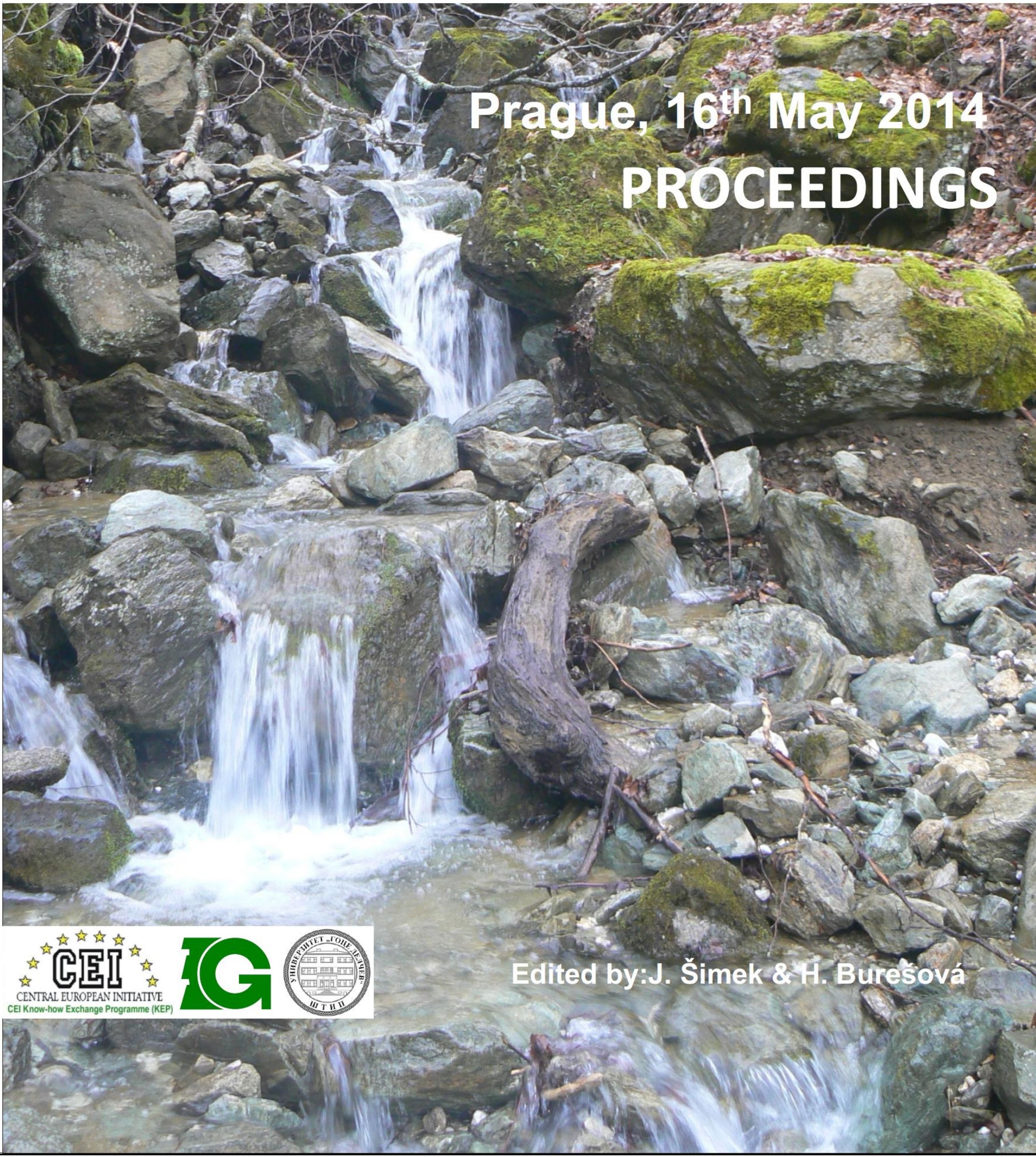
ENIGMA 2nd INTERNATIONAL WORKSHOP

GIS-GEOINDUSTRY, s.r.o., Czech Republic   CEI Know-how Exchange Programme

2nd INTERNATIONAL WORKSHOP

Environmental impact assessment of the Kozuf metallogenic district in southern Macedonia in relation to groundwater resources, surface waters, soils and socio-economic consequences (ENIGMA)



Prague, 16th May 2014

PROCEEDINGS

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Edited by: J. Šimek & H. Burešová

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CENTRAL EUROPEAN INITIATIVE
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USE OF THE SURFER PACKAGE IN THE INTERPRETATION OF THE GEOCHEMICAL DATA FROM THE ALSHAR MINERALIZED AREA, R. MACEDONIA

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Abstract: Within these trials were treated results of 288 lithogeochemistry and 362 soil samples. Gold, silver and arsenic were the elements selected for the geochemical interpretation in the Surfer software package. Gold anomalies in lithogeochemical samples ranged from 0.31 up to 19 ppm Au while in the soil samples concentrations ranged 1-5 ppm Au. Silver anomaly values, in soil samples, were within the range 0.34 ÷ 19 ppm Ag and for arsenic values were 4÷2001 ppm As. Mercury, antimony and thallium were enclosed within this geochemical study, but however they were not taken into consideration for the Surfer helped interpretation. The 3D model displays the hypsometric difference in the distribution of gold of 170 m, from level 730 m up to level 900 m. Lithogeochemitry map of gold shows linear orientation of anomalous concentrations probably due to deposition of gold along the fault structures of north-west direction.

Key words: Lithogeochemical study, geochemical anomaly, Surfer interpretation, gold, silver, arsenic.

INTRODUCTION

In the Alshar area were performed geochemical studies between 1986 and 1989 with main goal to define in more details the hydrothermal anomalous zones discovered by the NASSAU Ltd. California, USA during the prospection of the area in 1986. The majority of exploration activities in 1986 have been focused on jasperoid antimony mineralization in underground workings as well as to the silicified tuff in the southern parts of the area. In the period 1987-1988 has been executed geochemical exploration program by net. The net consisted of 25 lines with direction E-W at distance of 50 m between each sampling line. The sampling points on each line have been located at distance of 10 m. In that way have been sampled 288 samples and their results were displayed at geochemical map of anomalies at scale 1: 1 000. Parallel to the surface sampling programme there was executed underground sampling at three main levels of the antimony addits.

The Alshar deposit was mined, intermittently, from about 1880 to 1912 for its arsenic ore, when the first discoveries of of Tl-minerals (lorandite, vrbaite) took place. Later exploration for antimony from 1958 until 1965, resulted in significant reserves of low grade antimony ore, however high arsenic contents in Sb-concentrates has precluded economic exploitation. Gold mineralization of probably economic importance has been identified and preliminary explored by Percival et al. (1990). Special interest for thallium as possible solar neutrino detector gave new impulse for systematical investigations of thallium mineralization. It should be epmhasized that the Alshar deposit is not fully explored and the metallogenic studies completed. The current investigations are still in progress.

For the results from previous studies of Alshar ore deposit the reader is reffered to Percival and Dickinson (1974); Hadzi-Petrusev, B., (1987); Boev, B., (1988); Boev et al. (1990); Boev and Percival (1990); Jankovic (1990); Percival (1990); Percival and Radtke (1990); Percival et al. (1992); Boev and Kovacev (1994); Percival and Radtke (1994); Boev and Serafimovski (1996); Jankovic et al (1997), Volkov et al., (2006), Boev and Jelenkovic (2012).

The major task of this paper was interpretation of geochemical data with support of the Surfer software package.

GEOLOGICAL FEATURES OF THE ALSHAR MINERALIZED AREA

This Alshar's igneous complex formed on a basement composed predominantly of the Triassic sediments, the Jurassic ophiolites (gabbro-peridotites prevails), and the Cretaceous sediments. Volcano-intrusive activity took place from 6 m.y. to 1.8 m.y.. The composition of rocks range from andesitic-quartz latite to rhyolitc and trachyte, enriched in potassium, rubidium, and cesium. Voluminous quantities of extrusive phases such as felsic tuffs, ash, tuff breccia and lacustrine volcanoclastic deposit are very widespread in the area; coeval subvolcanic and hypoabyssal intrusions have been exposed at several localities. Some of the volcanic complexes display ring-radial structures. The basement of the Alsar deposit consists of the Triassic rocks such as schists and carbonate rocks. Along the western margin of the deposit small outcrops of the Jurassic peridotite occur occasionally. The mesozoic rocks are unconformably overlain by late Pliocene cover, and glacial till. The earliest Tertiary rocks are tuffaceous dolomites locally intercalated with sequence of tuff, waterlain ash and volcanic glass. The felsic tuffs unconformably overlies the tuffaceous dolomite, and locally the Mesozoic basement rocks. The subvolcanic latite intrusions cross cut both Mesozoic and Tertiary rocks; they outcrop locally as minor exposures, but large latite bodies are revealed by the underground antimony/arsenic mining workings in the central part of deposit.

SAMPLING AND METHODOLOGY

In the Alshar area were performed geochemical studies between 1986 and 1989 (NASSAU Ltd. California, USA) when a total of 650 samples have been collected from the hydrothermally altered surface outcrops. All the collected samples from lithogeochemical and soil prospection were prepared with Johnson crusher and pulverized. Each sample was then split into four portions using a rotary divider, two of which were archived for further studies and the rest was pulverized in a agate planetary mill to a grain size <0.063 mm, homogenized and submitted to the analytical laboratories. Prepared samples were analyzed in the Hunter Laboratory in the USA while each fourth sample has been analyzed in the Buchim Mine laboratory near the city of Radovish, R. Macedonia. Samples sent for analysis to the USA were analyzed to gold, arsenic, antimony and mercury with use of cupellation and atomic absorption spectroscopy while the samples sent to the Buchim Mine's laboratory were analyzed only to gold on atomic absorption. Several samples were analyzed on XRD in laboratories of the Faculty of technology and metallurgy in Skopje.

RESULTS AND DISCUSSION

To be able to develop any kind of discussion about the perspective of the explored area it was necessary to perform statistical data analysis of the laboratory results. Complete interpretation was possible after the statistically analyzed data, determined average value of particular element and threshold. After these preliminary tasks it was possible to perform categorization of anomalous samples. Also, here we would like to stress that the statistical analysis was performed separately on different kinds of samples (surface lithogeochemistry, adits lithogeochemistry etc.). This approach allowed us to be able to determine the vertical distribution of gold and some other metals of interest.

Gold interpretation

Based on the results gained from earlier investigations which consisted of sampling and laboratory analyses, the present authors offer a new geochemical understanding of the area of interest gained from the application of new computer software packages (Surfer, Excel) and profound geological analysis.

Interpretation of gold from the lithogeochemical prospection has shown that of 288 sampled locations in 156 samples was determined gold (Figure 1) with concentrations of at least 0.03 g/t. According to the statistical analysis was determined the threshold of an anomaly, which was set at 0.31 g/t Au. Interpretation of geochemical data consisted of explanation of the vertical distribution in the area or, more specifically, the relief distribution in the Alshar deposit. In that regard, computer software was applied and 3D model of gold spatial distribution is given in Figure 1. Intervals of distribution in every presentation equals 1 ppm.

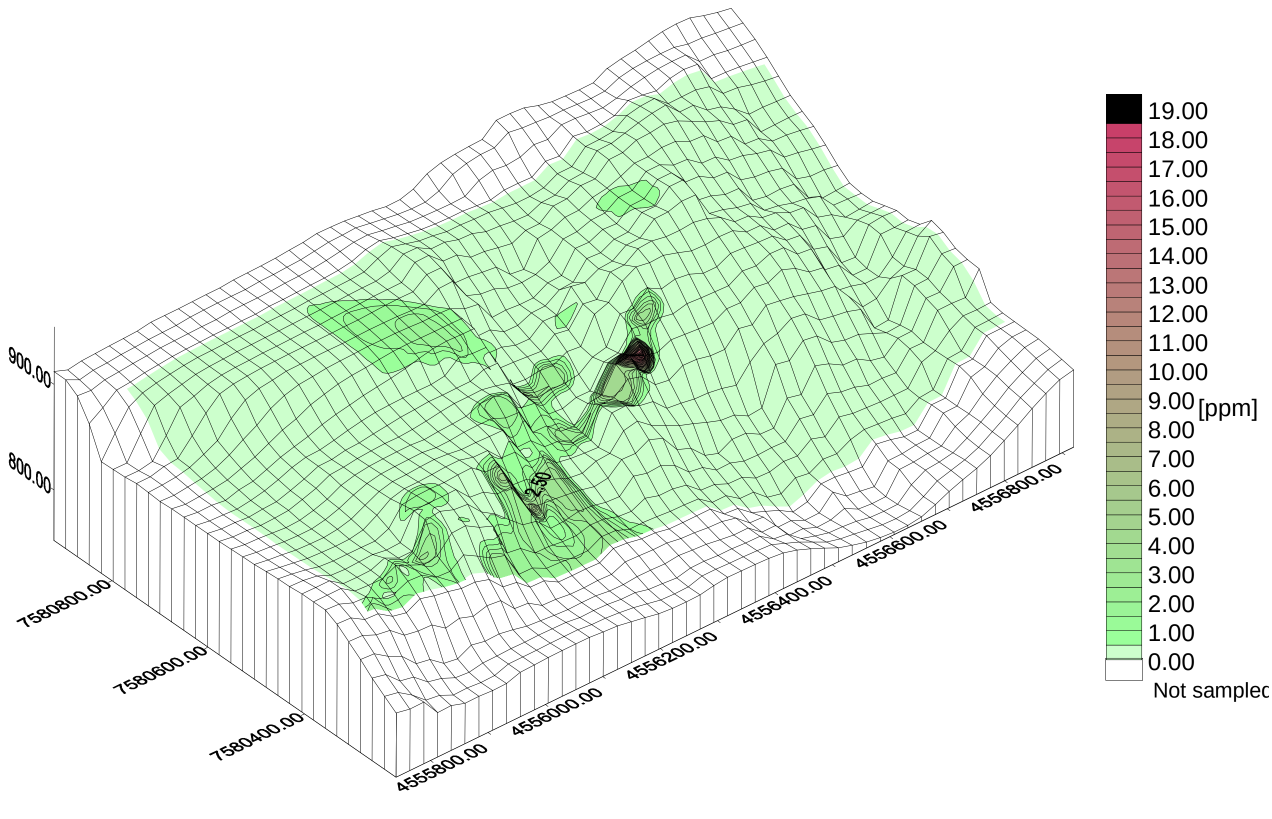

Fig. 1. Hypsometric review of gold contents in all sampled specimens

After determination of the background value of gold (0.31 ppm), samples with contents of gold lower than the background values were omitted from the three-dimensional review of gold distribution and from the areal review (background values and above background values). This gave a completely different review of the gold distribution (the oblong large light grey area). It is clear that major ore formations are of north-south strike orientation (northeast - southwest) and follow the fault structures. It can also be said that the contents in the omitted samples can be regarded as dispersion halos of gold mineralization. The figure shows that the spatial review is consistent with the interpretations in the histogram, or that the highest gold distribution occurs between 800 m and slightly beneath 900 m above sea level.

The two-dimensional review of gold distribution Figure 2, (anomalous contents only) constitutes another proof of the data given in Figure 1. Similarities with the two-dimensional model created by Hadzi-Petrusev (1987) are noticeable as well. It is clear that mineralization (above background values) occupies a large portion of mineralized area which is 1100 m x 400 m in size. Inference was made that gold distribution is of northeast-southwest strike orientation and follows the fault structures that served as path ways for the migration of the hydrothermal mineralization solutes. It is also noteworthy that the highest gold concentrations are found in the central portions of the area of interest and along the western side of the net for sample collection. This is due to the favourable lithological environment (in terms of porosity and permeability) for the migration of the hydrothermal solutes into the rocks.

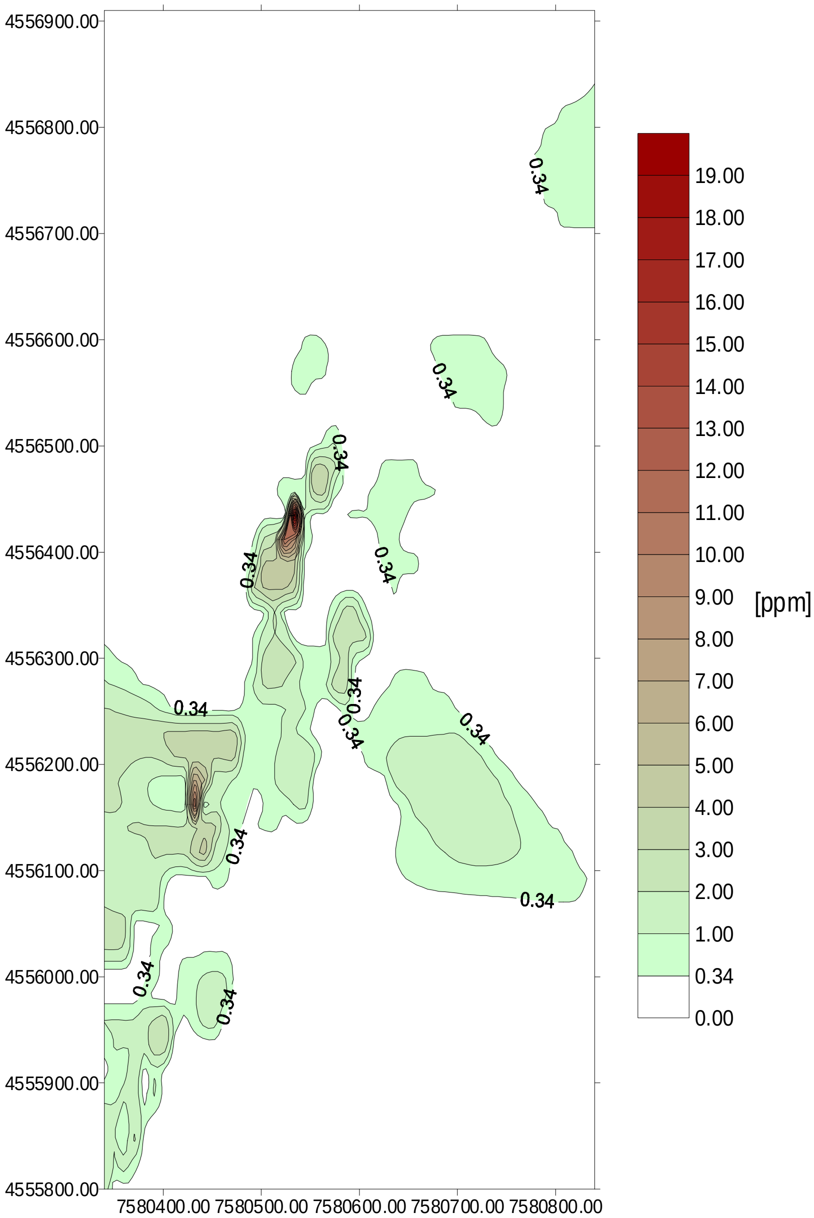

Fig. 2. An isolines map displays particualr gold anomalies (lithogeochemistry) in central and southern part of the Alshar deposit

During the gold data analysis it was possible to conclude that all the anomalous samples came from the southern parts of the explored area. They were located in silicified dolomites. Increased concentrations were related in general to the zones with the most intensive silicification.

Analysis of gold in 362 soil samples have shown quite similar distribution pattern of this element as seen for the lithogeochemical data (Figure 3).

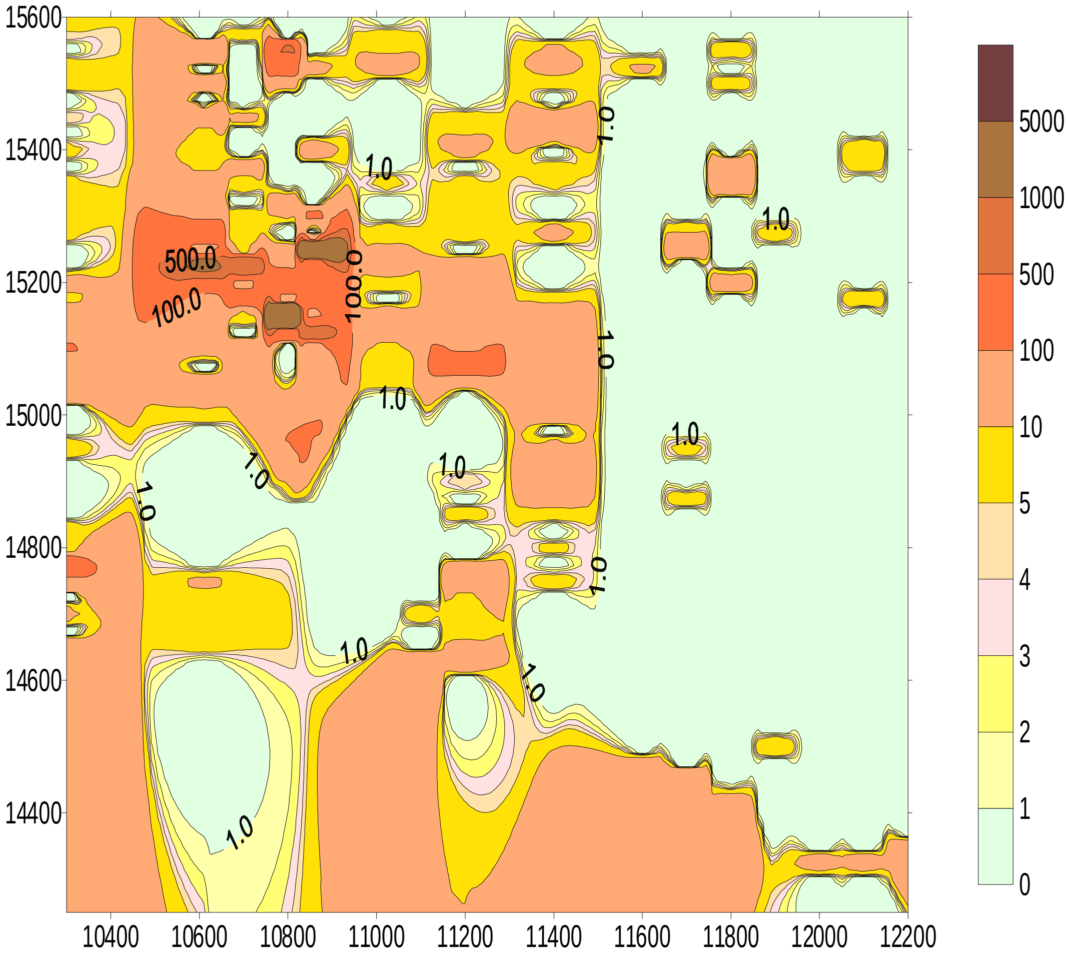

Fig. 3 An isolines map displays particualr gold anomalies (soil geochemistry) in central and southern part of the Alshar deposit (isolines concentrations are expressed in ppb)

Soil gold anomalies were with north-south direction plunging under the non-silicified dolomites in the central parts. The continuity of anomalous fields at certain positions has been interrupted by local tectonics that have been confirmed in the explored area.

Interpretation of silver

Interpretation of silver in soil samples have shown that of 362 samples in total, silver occurred in 263 samples and it was in the range 0.34 g/t to 19.20 g/t Ag. According to the statistical data analysis it was calculated the treshold of the anomaly, which was set at 1.87 g/t Ag. Anomalous samples were grouped in three categories:

I category 1.87-3.17 g/t

II category 3.18-5.40 g/t

III category ≥ 5.41 g/t

If monitor interpreted data of anomalous samples there could arise several conclusions: anomalous fields in the area are disseminated, but however they show correlation with particular geological settings.

The majority of anomalous fields have been located along the western side of the studied area. Anomalies occur in settings that have undergo certain hydrothermal alterations (silicification, limonitization and kaolinization). Anomalous fields were located along the megastructure of north-south direction. Occasional small anomalous fields point out to a possibility that its distribution could be expected on the wider contact between the andesite intrusions with adjacent rocks.

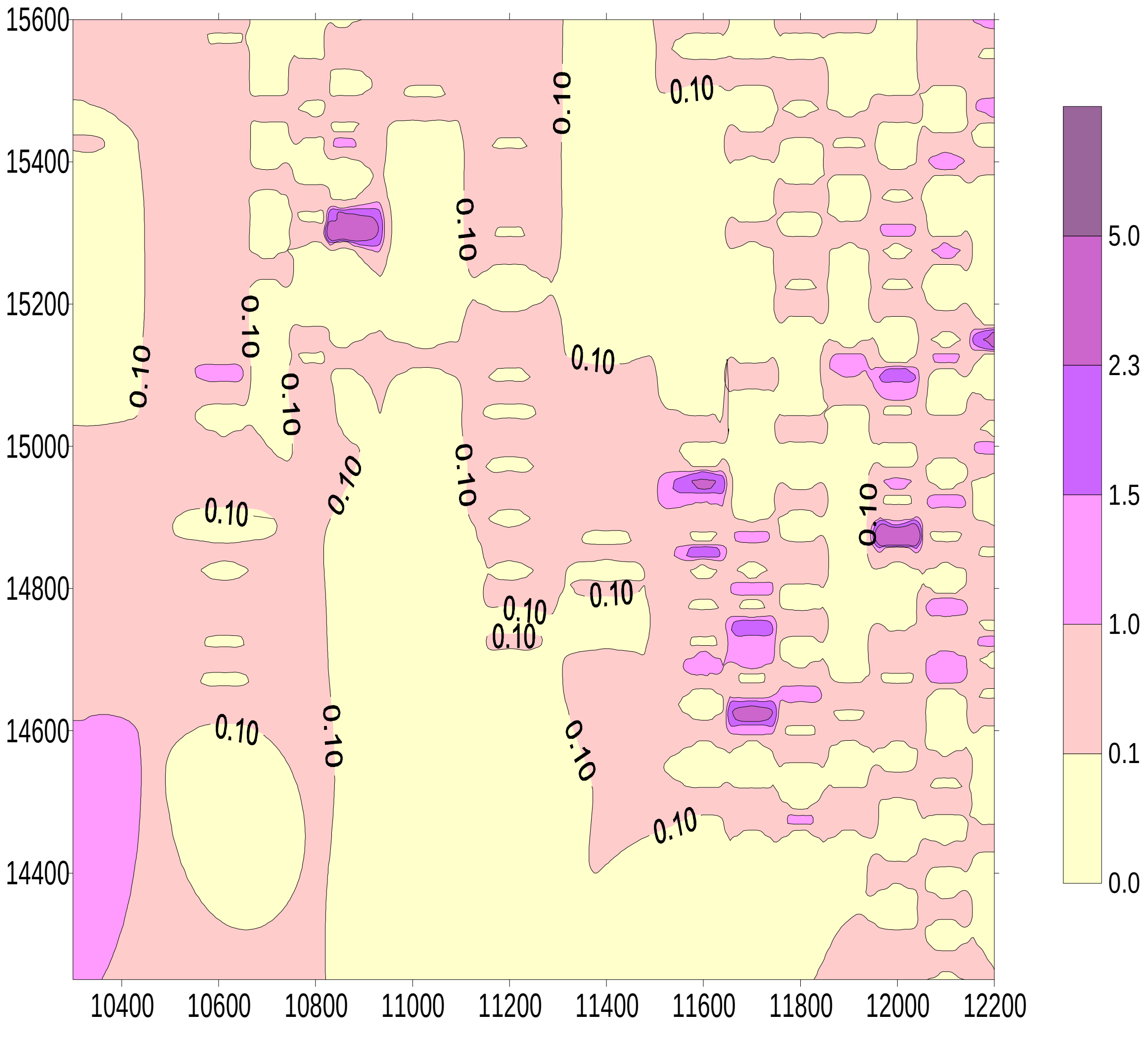

Fig. 4. An isolines map displays particualr silver anomalies (soil geochemistry) in accordance to data from soil samples analyses in the Alshar deposit (concentrations in ppm)

If we closely monitor the distribution of anomalous fields of silver, we can conclude that its distribution is strictly limited to particular lithological units. Silver was determined in silicified dolomites, flour-like dolomites and silicified dolomites mineralized with antimony and arsenic.

Significant factor in distribution of silver was that it keeps its continuity, which later proved to be very important in selection of exploitation method. The degree of continuity is the lowest over silicified dolomites mineralized with antimony and arsenic ore.

Interpretation of arsenic

The fourth element that was analyzed at the studied area is an arsenic. Within 362 samples in total, in 293 samples it was determined increased presence of arsenic while in 123 of them arsenic concentration was even higher than 1000 ppm (Figure 5). This information made the statistical data analysis more complex. During the calculation of the treshold value of anomaly, as the first stage were eliminated samples with an arsenic concentration higher than 1000 ppm. Calculations have shown that the treshold value can be set at 80 ppm As. Bearing that information in mind it was performed categorization of anomalous samples:

I category 80-320 ppm

II category 321-960 ppm

III category ≥ 961 ppm

From the interpeted data above it can be concluded that an arsenic distribution has been located along a megastructure with nortwest-southeast direction and it follows silicified, kaolinized and limonitized dolomites (Figure 5). The highest intensity of anomalous fields has been determined above silicified dolomites (brown colors).

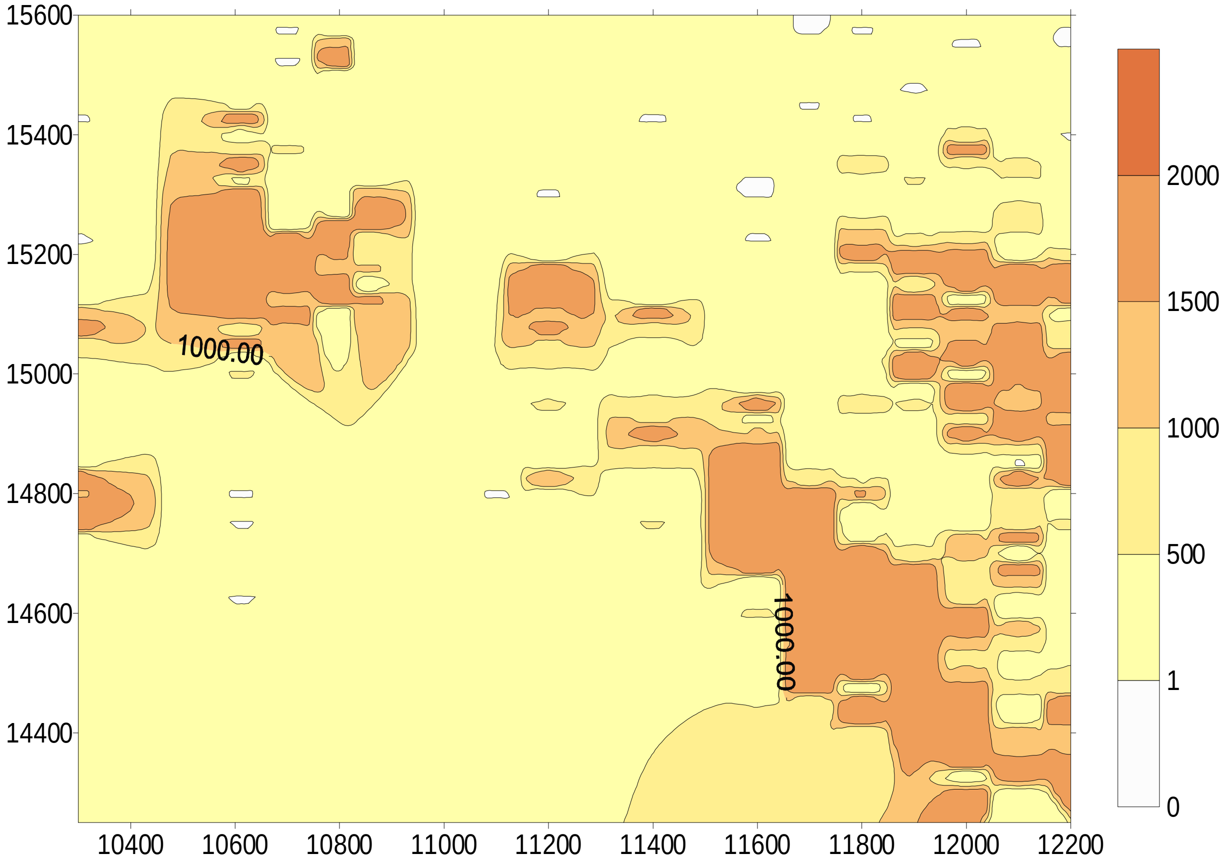

Fig. 5. An isolines map displays particualr arsenic anomalies (soil geochemistry) in accordance to data from soil samples analyses in the Alshar deposit (concentrations in ppm)

The graphical presentations given below are for more illustrative display of above mentioned data and conclusions.

CONCLUSION

The geochemical study of the Alshar mineralized area confirmed presence of increased, anomalous, concentrations of gold, arsenic, antimony and silver. Gold anomalies mark the paths of all major structure zones in the Alshar area with general direction of north-south, which coincide to a proven control of mineralizing fluids along those fault zones. Arsenic and antimony anomalies confirm paths of already proven ore bodies in the As-Sb deposit Alshar. Interpretation of geochemical data with support of Surfer software package allowed pure definition of anomalous zones and correlation between gold anomalies and other elements of interest, too.

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