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3D MODELLING OF THE PLAVICA Au-Cu POLYMETALLIC DEPOSIT, REPUBLIC OF MACEDONIA

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A b s t r a c t: The latest exploration and study of the high sulfidation epithermal deposit of Plavica displayed significant progress in understanding the geology and definition of the particular ore body. The results from boreholes made by Genesis Resources International DOOEL Skopje, Republic of Macedonia, in 2011, 2012 and 2013 were: 51 m interval with 3.9 g/t Au in oxidation zone, 65 m interval with 3.1 g/t Au in oxidation zone, 51 m interval with 3.7 g/t Au, 2.8% Cu and 16 g/t Ag in sulfide zone. For this 3D model all 195 boreholes made by the Genesis Resources International were used. The boreholes were made in the period of 2011–2013, with total length of 47295.8 m of which 74 boreholes were performed by diamond core method and total length of 23908.3 m while the other 121 boreholes were performed by rotary circulation (RC) with total length of 23387.5 m. Using professional ArcGIS software were prepared 3D models of the ore body for gold and copper, at respective resolution of 30 m and 10 m, for each element, which have defined mineralization extent from 1305 m to 600 m of the hypsometric level. These models should improve our understanding of the ore mineralization and complement the geological data of the Plavica ore deposit.

Key words: 3D model; Plavica; gold; copper; epithermal

INTRODUCTION

Polymetallic gold, copper and silver ore deposit Plavica is part of Kratovo–Zletovo volcanic area in the NE part of the Republic of Macedonia. It occupies the central part of the Plavica mountain (1290 m) and is located between cities of Probištip (6 km distance) and Kratovo (4 km distance). The Plavica deposit is well known to the local and regional community. Its exploration and exploitation history (in the central parts known as Zlatica) reaches back to Roman times when were undertaken large-scale mining and processing of copper from pyrite-enargite veins (sporadically limited exploitation of silver and lead). Limited mining took place here during and after the so called 'Turkish' era (XV–XVII centuries) when gold was extracted for production of coins. The British company Selection Mines Ltd carried out some exploration in the area and further exploitation of enargite veins between 1934 and 1936 (with more than 2800 m of underground exploration workings). Later on an intense programme of exploration and drilling was undertaken by the Zletovo mine and the Geological Survey in the decades following the Second World War (1945–1952; 1961–1962 and 1963–1974). Based on those explorations an extensive programme prepared was by the Geological Survey and RIK "Sileks", realized in the period 1976–1986 (with respectable 30 325 m of exploration drilling). From the late 1980 s, there have been several, further, exploration programmes for Cu and Au by foreign mining companies (e.g. Cominco, Cyprus Amax, Minorco, Goldfields, Rio Tinto, European Minerals) with the emphasis more on Au associated with the peripheral silica bodies. The latest exploration in the Plavica concession area was performed during the period 2011–2014 by the Australian company Genesis Resources International Ltd. All those explorations contributed to an intensive professional and scientific database where we would like to point out the workings of Pendžerkovski et al. (1960), Mijalković and Pešić (1966), Janković (1967), Marković (1971), Pantić et al. (1972), Ristić and Klajn (1973), Stojanov (1974, 1980), Bilibajkić and Bilibajkić (1978), Petković and Romić (1977), Ivanov and Denkovski (1978, 1980), Rakić (1978, 1982), Janković et al. (1980), Mudrinić (1982, 1986), Drovenik et al. (1983), Bogoevski and Rakić (1985), Stojanov and Serafimovski (1990), Serafimovski (1990, 1993), Stojanov et al., (1995), Tomson et al. (1998), Serafimovski and Rakić (1998, 1999), Serafimovski and Tasev (2003), Stefanova (2005), Alderton and Serafimovski (2007), Stefanova et al. (2007), Volkov et al. (2010), Stefanova et al. (2013) and Zlatkov et al. (2014).

During last two decades the 3D geologic modelling has evolved from the application of computer aided design (CAD) software into a matured Earth science discipline that covers geomathematics, geophysics and geology. In that direction 3D and 4D modelling are the new exploration tools that can help the mineral explorers to visualize, interpolate and interpret geological data, are a critical time and money-saving methods. This particular model was built in Target 3D for ArcGIS system, and using this as a basis for modelling of the certain Au-Cu ore body. A better understanding of the geometry and intensity in 3D may lead to new discoveries within the deposit area.

METHODOLOGY

The database with drill core collar, survey, assay and all the data have been provided by Genesis Resources International DOOEL Skopje. The database contains information from 195 boreholes with individual length of up to 594.1 m. Although exploration concession is for 17.41 km^2, the latest explorations displayed within this paper covered an area of 0.63 km^2, which have been estimated by geological experts as the most promising one. Drillholes have been spaced 50 to 100 m between each other and sampled at 1 m intervals, in that direction the total database consists of 43965 sampling results (multi-elemental). All of the drill holes were located using GPS, and these coordinates and elevations were recorded. The database provides information about the location of drillholes, their depth and orientation, lithology, mineralogy, and geochemistry (Atomic Adsorption Spectrometry – [AAS] and Inductively Coupled Plasma Atomic Emission Spectrometry – [ICP-AES], analyses of 36 chemical elements). Cut of grade for gold was calculated at 0.2 g/t Au while for copper it used to be at 0.2% Cu.

For the construction of the Plavica deposit 3D model was used Target 3D, which was developed for the Target for ArcGIS system. This particular system enables to display drillhole, surface and other data types in an interactive three-dimensional environment. The *Target 3D Viewer* enables three-dimensional viewing of our data. Drillholes are displayed in their "true" three-dimensional location and can have up to two different data types plotted along their trace. Grids created in "sectional" views (e.g. from Target or Interactiv IP applications) can be displayed directly into the 3D view, in their correct orientation, using Geosoft's "on-the-fly" technology. Other grids and images (including bitmaps and jpegs) can be opened and easily located in any specified orthogonal plane. 3D "Voxel grids" can also be displayed in a 3D drillhole map and modified using the Target 3D Tool. 3D Voxels can be created using the Voxels/Grid Voxel menu item, on the Target 3D Toolbar.

GEOLOGICAL FEATURES AND MINERALOGY OF THE DEPOSIT

The Plavica deposit is a part of well known Kratovo–Zletovo ore area that in general is characterized with a complex composition of mainly Tertiary volcanic-sedimentary complex imposed on the foundation of the Serbian–Macedonian massif, which represents constituting part of the western Tethyan belt. K/Ar radiometric data (Karamata et. al., 1992) yield an age of 32–16 Ma (late Oligocene to middle Miocene). In the geological setting of the Plavica deposit participate mainly volcanic and volcano-sedimentary rocks, which exact determination is complex due to intesive presence of hydrothermal alterations (Figure 1).

However, with numerous lithostratigraphic and petrographic studies it was confirmed that in the geological setting of this deposit participate ignimbrite, stratified volcanic tuff and breccia, dacito-andesite and their pyroclasts as well as quartzlatites that the most often occur as breaktroughs. Definition of these rocks is hard because of intensive hydrothermal alterations as are: kaolinization, silification, alunization, seritization and other. The central part of Plavica is made of different kind of volcanic rocks, hydrothermally altered, pyritized, and mineralized with ore mineralization (Cu, Au, Ag, Pb, Zn). According the research made on Plavica mainly based on boreholes data, the depth of the ore mineralization and intensive hydrothermal alteration exceedes 1000 m.

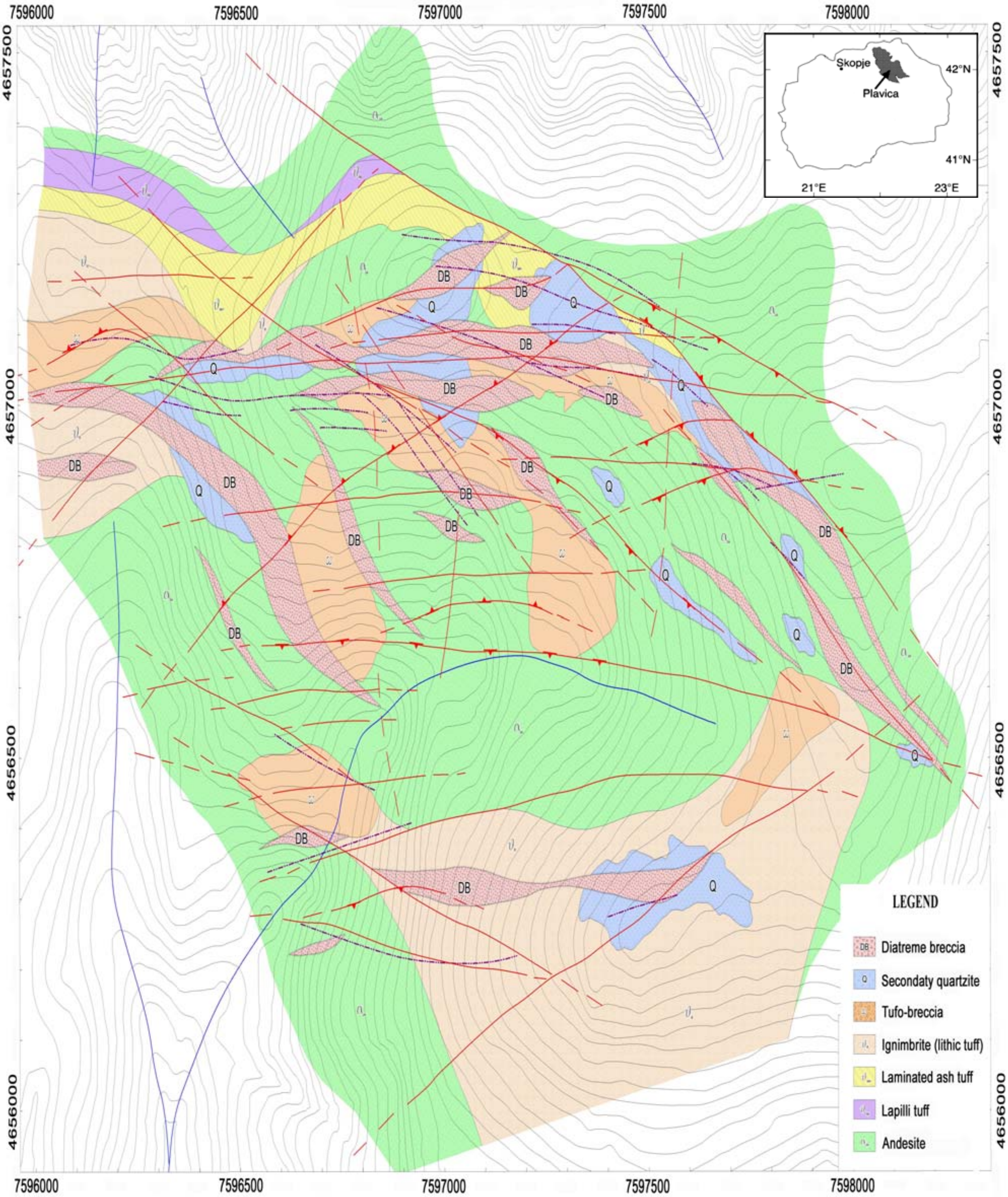


Fig. 1. Simplified geological map of the Plavica deposit area (Ivanovski, 2014)

The silica ledges seen on Plavica represent the level of paleo-regional ground water table. Due to their silica content both areas have resisted erosion and through topographic inversion have formed prominent landforms (Figure 2). The extend of erosional landform processes is illustrated in the surrounding region by the widespread occurrence of large scale block slides, slumps and smaller scale mud slides. Landform failure appears to have occurred along steeply dipping contacts between individual sub-aerial volcanic flow-air fall units and regions of subaqueous reworked volcanic detritus. The contacts between these units quite commonly show quartz-sericite clay alteration after pyrite thus contributing to the loss in rock strength and consequent landform failure. The volcanic units of Plavica are protected from erosion by the widely distributed silica ledges (Figure 2) and these units dip towards the SE (Cuthberston, 1998). The Plavica area is underlain by a thick section (nearly 500 m) of intercalated volcanic flows, tuffs, debris flows and subvolcanic intrusions.

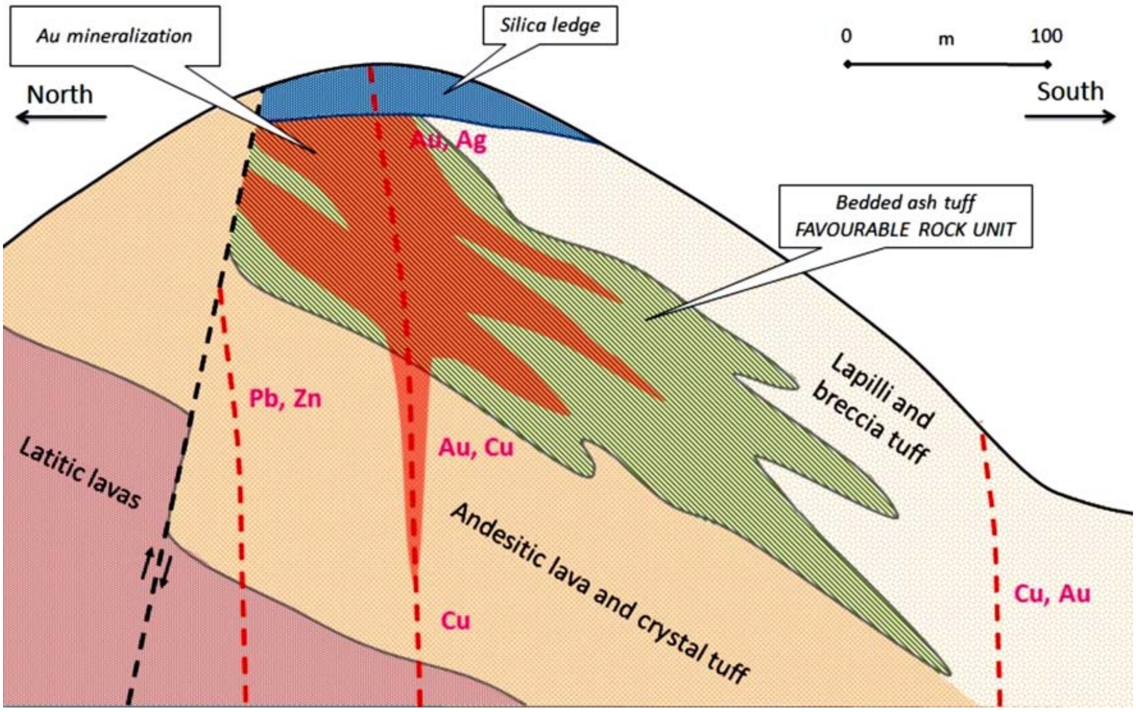


Fig. 2. Plavica conceptual cross-section (Stevanović, 2014)

Flows and massive tuffs ranging in composition from andesite to latite, comprise the basal portion of the volcanic sequence and are overlain by a series of debris flows with intercalated water-lain tuffs, tuffs and volcano-clastic sediments. In addition, the extensively developed hydrothermal alteration, faulting, and large amounts of alluvial cover complicate attempts to make detailed stratigraphic determinations (Percival, 1992). The geology of Plavica consists of a package of a high level intermediate volcanics of mixed sub-aerial and sub-marine facies. The package varies from coarse grained crystal and lithic tuffs to finely laminated sub-aqueous epiclasts that dip approximately 30° to the SSW. This volcanic package is cut by apparently sub-vertical vuggy silica bodies of narrow extend (100–150 m) that, due to erosion and topographic inversion have become topographic hights (Fish, 1998; Fish, et al., 2000).

The Eocene–Miocene igneous rocks associated with the area are mostly of an intermediate, calc-alkaline/high K-composition (especially granodiorite, quartz, monzonite, quartz diorite, andesite and dacite). The present level of erosion is such that the igneous rocks currently exposed are mostly high level volcanics and pyroclastics (Alderton and Serafimovski, 2007).

Tertiary rocks are the dominant lithology at the Plavica area, review of these numerous and different types of rocks will be present according their geochronological order defined on basis of the found fauna superpozitional relations and absolute age of certain types of volcanic rocks (Serafimovski et al., 2014)

Ignimbrite of dacite-andesite composition are present on NE slopes of the Plavica (Trnjak, Golak, Ramna Niva) and in one wide band envelope southern slopes of the Plavica. They are represented by grey-green to reddish color and composition variable at short distances (andesite-dacite-quartzlatite). Due to their structural setting and inclusion of some older rocks some authors named them as ignimbrites. These rocks are known for the presence of numerous lead-zinc ore veins. This quite well fits Plavica deposit into the explanation that although the most high-sulfidation deposits are generated in calc-alkaline andesitic-dacitic arcs characterized by near neutral stress states or mild extension, few major deposits may also occur in compressive arcs characterized by the suppression of volcanic activity (Sillitoe and Hedenquist, 2003), as it is shown in the text that follows, too.

Volcano-sedimentary rocks (stratified tuff) are well spread on the northern margins of the Plavica in an elongated belt starting from Šlegovo village and ending to the east, near the Siroka Padina locality. Their presence points out that some of the volcanic stages occurred in submarine or sublacustrine conditions. These rocks are sometimes hydrothermally altered, mainly, along the cracks and fissures.

Propylitized dacite-andesite rocks are the rock counterparts of former composition strongly hydrothermally altered and spread over northern slopes of the Plavica (Rajkovac, Golak, Trnjak) and southern part of the Maričanski Rid. Hydrothermally altered andesite rocks were determined in western and southwestern margins of the Plavica (saved fenocrystals and some colored copmounds that easily can be classified as biotite-hornblende andesite).

Quartzlatites were determined at several locations (Karac, Dogandziski Kamen, Plavički Potok). In general they occur as neck, stock and dyke forms that break-through the adjacent dacite-andesite or their tuff counterparts. These rocks are built of cryptocrystalline quartz, K-feldspar with phenocrysts of sanidine, biotite and quartz and characterized by porphyry structure and massive texture.

Dykes are common at several places, especially on the northern margin of the Plavica area, where they break-through the dacite-andesite and pyroclasts.

Silex-secondary quartzite in the central part of the Plavica have a significant distribution. They build the highest parts of the Plavica and stick out of the ground in the form of chops and occur in two elongated zones: northern and southern. Towards the east these silex ore bodies contain significant amounts of alunite that gradually turns into alunite quartzite. It is interesting to note that the silex-secondary quartzite except traces of sulphides contained in itself and some quantities of gold (0.1–3.0 g/t Au). Their transition towards the surrounding rocks are usually not sharp and they gradually transform into the surrounding rocks in form of more or less pronounced silification.

At the highest parts of the Plavica at several locations there are increase quantities of diluvial sediments (Beglički Livadi and Dolno Kadiski) in streams of northern slopes and remains of the ancient river terraces.

In regards to the ore mineralization within the Plavica deposit, we would like to stress out that it has been deposited in empty spaces in fault-crack systems, veins, veinlets and metasomathically has been impregnated in adjacent hydrothermally altered volcanic rocks. Mineralization of impregnated type is the most common near the cracking systems. The mineralization occurs in four distinct settings: (i) stockwork and disseminated Cu–Au (+Mo, Ag) mineralization occurs in the central and deepest part of the system; (ii) veins of quartz, pyrite, sphalerite and enargite (± gold) occur at intermediate levels and appear to be superimposed on the stockwork; (iii) silica bodies occur peripheral to the central zone (ore bodies consist of quartz plus some opal and are sub-vertical in orientation); (iv) small veins with enrichments in Pb and Zn (up to 1% combined Pb–Zn), similar to the larger Pb–Zn veins worked in the nearby Zletovo mine, but much smaller. We would like to point out that the detailed exploration performed by the Genesis Resources International DOOEL Skopje, which study was concentrated mostly in the north-eastern part of the Plavica deposit (mineralized area known as Plavica–Zlatica) and hill top where dominate secondary quartzites. Those extensive exploration activities defined one new Cu–Au mineralization type where dominate epithermal gold of high sulfidation with representative elongated lens-like ore bodies, which follows the structural controlling forms (Figure 1 and Figure 2).

The mineralogy of the Plavica deposit is complex and several paragenetic stages have been suggested (Ivanov and Denkovski, 1978). The latest data about the mineralogical composition of the Plavica deposit can be found in detailed electron microprobe study of Serafimovski (1993), where the mineral presence and their association has been brought to an higher level of knowledge. Also, later findings of Serafimovski and Rakić (1998), Serafimovski and Rakić (1999), Alderton and Serafimovski (2007), Stefanova et al. (2013), Serafimovski and Tasev (2013) and Zlatkov et al., (2014), contributed to a better understanding of the mineral composition of the Plavica mineral deposit. With up to date studies has been confirmed that within the Plavica–Zlatica deposit can be found the following ore minerals: pyrite, pyrrhotite, chalcopyrite, magnetite, rutile, scheelite, hematite, molybdenite, galena, sphalerite, bornite, enargite, native gold, melnikovite, tetrahedrite, tennantite, chalcocite, digenite, covellite, proustite, native copper, malachite, azurite, and some other. The latest study have confirmed presence of seligmannite, luzonite, famatinite, petzite, bogdanovite, bezsmertnovite, sylvanite, pearceite, bilibinskite etc. (Serafimovski and Tasev, 2013). Of the nonmetallic minerals the most common were quartz, calcite, siderite, oligonite, chalcedony etc. The common presence of copper minerals, especially the high-sulfidation state sulfosalts enargite-luzonite (White et al., 1995), as well as relatively high-sulfidation state minerals tennantite-tetrahedrite (Barton and Skinner, 1979), was the factors leading us to classify deposit as high-sulfidation type. Also, only scarce sphalerite and arsenopyrite confirmed our conclusion about the type of the deposit. High-sulfidation mineralization in the Plavica deposit is characterized by the presence of high-sulfidation – state sulfide assemblages dominated by pyrite, sulfosalts (enargite ± luzonite), digenite, bornite and lesser covellite, chalcocite, chalcopyrite, tenantite-tetrahedrite and molybdenite. Traces of colusite (Cu-Sn-V-As-Fe sulfide), sphalerite and galena have also been reported (Serafimovski et al., 2014) quite similar to genetically same deposits worldwide (Madera, 2000). The most common copper sulfides display a very distinctive replacement sequence from bornite → digenite → chalcocite → exsolution covellite (Zlatkov et al., 2014).

3D MODELLING, RESULTS AND DISCUSSION

A comprehensive and in many ways detailed study conducted at the Plavica, beside geochemistry and geophysics, included respectable array of 195 exploration boreholes totaling of 47295.8 m. One part of them, 74 boreholes, were with diamond core and total length of 23908.3 m with average depth od 400 m. The rest, 121 reverse circulation (RC) boreholes, were with total length of 23387.5 m and average depth of 200 m. All boreholes are with different azimuths and dips, but most of them are with azimuth of 360° and dip of –60°. We used all the boreholes, including the negative one so we can get more representative situation in the 3D modelling. The study results have shown interesting gold and copper concentrations in certain mineralized zones, which represents the basis for construction of ours 3D model with use of professional computer software package Target 3D for ArcGIS.

Using the Target 3D Tools enables us to interactively control the transparency of individual items, enabling data to be displayed with a cumulative (light-table) effect as it was already mentioned elsewhere (Ligovski et al., 2014). Data such as Maplnfo tables and 2D DXF files can be imported directly into the 3D environment and drawn on any surface displayed in the current 3D view.

The Target system automatically detects the type of data that is being imported, including: drillhole (collar) locations with their unique Hole ID, Easting (X), Northing (Y), Elevation (Relative Level) and Total Depth (EOH) where the X, Y and Depth must all be in the same units. The Azimuth and Dip are also included in the collar file. Geochemical assay data are typically acquired by obtaining core or rotary drill samples over specific depth ranges (from-to ranges) and sending samples to an assay laboratory. Numerical results are typically returned from the laboratory in electronic format and can be imported quickly into the system. Before import, we must make sure that our data files contain the following information – HOLE ID, FROM, TO and a series of ASSAY results. On the DH-Data menu, click Import and then select Text File. Drill Hole menu>Ascii Import Wizard > Browse > KZM_ASSAYS (see Ligovski et al., 2014).

To start the work with Target 3D we selected an area that we would like to concentrate on from the Hole Selection Tool. This particular step enables us to display only the area of the project that is of interest. Target Drillhole > Hole Selection Tool dialog appears > Select using polygon tool to define a polygon around the holes required. However we had to create a Target 3D Voxel Grid, which selects the holes we would like included in our Target 3D Voxel grid, using one of the Hole Selection Tool options, too.

From the Target Drillhole toolbar, we have to select Voxels > 3D Gridding from Current Geosoft Database > and 3D Gridding dialog is displayed. To Create a Target 3D Map On the Target Drillhole toolbar > Generate 3D Drillhole Plot b > 3D Map Parameters dialog, Page Layout tab, on the 3D Map Parameters dialog, is displayed by default. The following page layout parameters can be controlled from this tab. Background Colour of the 3D view Axis Colour and Font used for annotating the 3D view. Plot Legend (right side of map), including company Logo (image file) and specifying the map Titles. Select the Hole Traces tab >. This tab dialog includes the following drillhole trace parameters: > Colour of the Hole Trace Hole Labels including location, annotations, text size, colour and font .Depth Ticks (annotations etc.) along the hole trace Select the Data tab. The Data and Plot types are selected from drop-down lists, just as you would select data for your Plans or Sections to be plotted. The three available gridding methods are Minimum curvature, Kriging and a TIN based technique. To define the Gridded data parameters> Define button. Plot topography box to enable the topography parameters using the Browse buttons, locate the Topography grid M01GGRD file and the Overlay grid on topography file. 3D block models were used to produce vertical and horizontal slices at required depth levels. "Chair clipping" view was created to visualize 3D distribution within the investigated area. Threshold attribute values have been used to create the isosurfaces or thres hold block models.

An element grade distribution block model was generated via ordinary kriging method. Ordinary kriging was developed by Matheron (1971) in the early sixties and plays a special role because it is compatible with a stationary model, only involves a variogram and it is the form of kriging used most in resource exploration (Chile's and Delfiner, 1999). Ordinary kriging estimates based on moving average of the variable of the interest satisfying different dispersion forms of data (Goovaerts, 1997). Although mineralization estimation of domains was modeled based only on metal grade, with definition of cut-off grade and top cut grade values for the Plavica deposit, the ore body was 3D modelled, with respect to intersecting fault zones, the overall geological setting and the compositional distribution of metal grades (Figures 3 and 4). Setting up the complete 3D geological model of the Plavica ore deposit all available data and sources of information were compared and integrated as it was case with 3D deposits elsewhere (Arvanitidis et al., 2013).

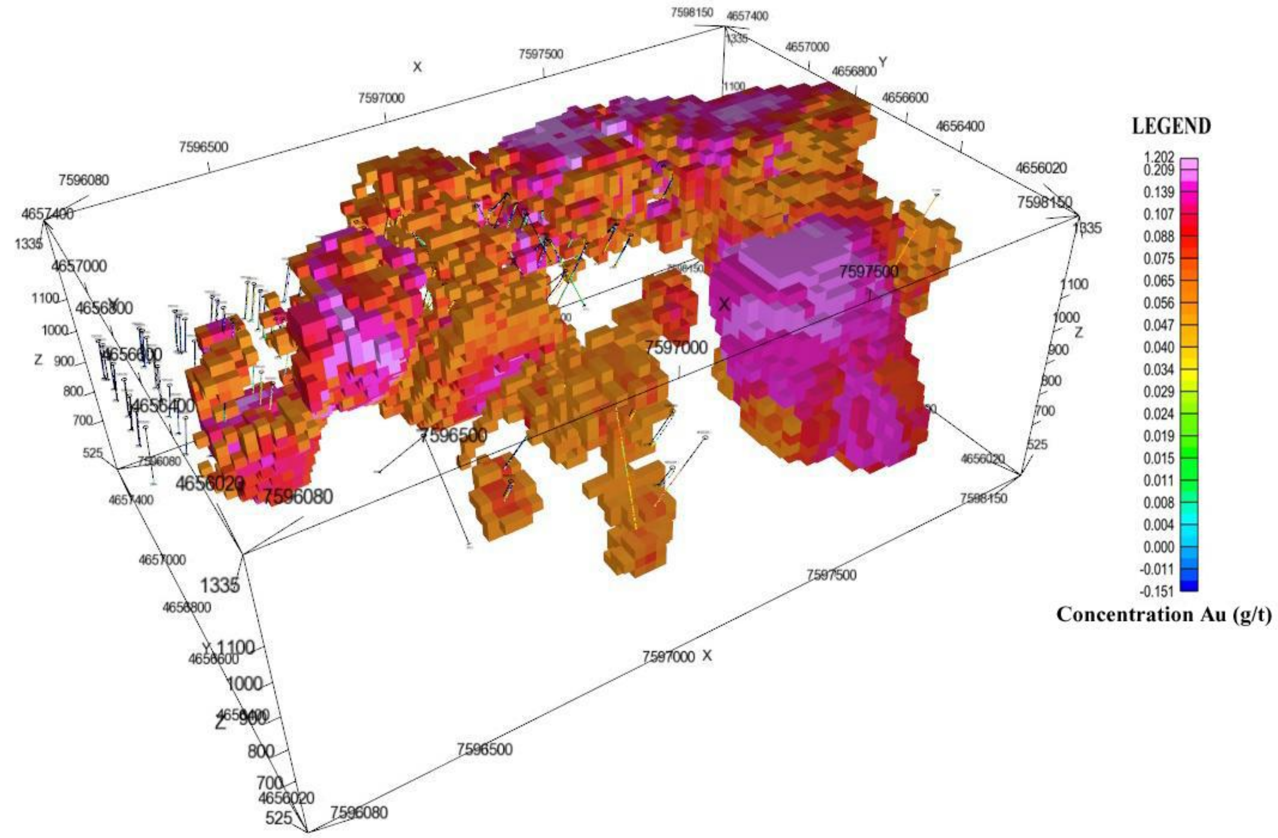
When plotted in 3D, the majority of the geochemical groupings had strong association with the lithologies of the deposit sequence (Figure 3a, b). The biggest advantages of constructing 3D volumes instead of 2D cross sections was the possibility to define ore grade volume gains and losses of the entire mineralized systems (Chmielowski et al., 2013; Christidis et al., 2014). In this direction we have proved that even with relatively slight changes in resolution (going from blocks formed at 30 m to blocks formed at 10 m), which have shown significant volume gains or losses of the entire mineralized, both for gold and copper (Figure 3a, b and Figure 4a, b), similarly to stated above.

Also, the contours of the ore bodies, both for gold and copper and both resolutions, have shown strong correlation to the fault systems in the area (being of N-S, NW-SE and sporadically SW-NE direction; see Figure 1) and respectively reflecting their spatial position.

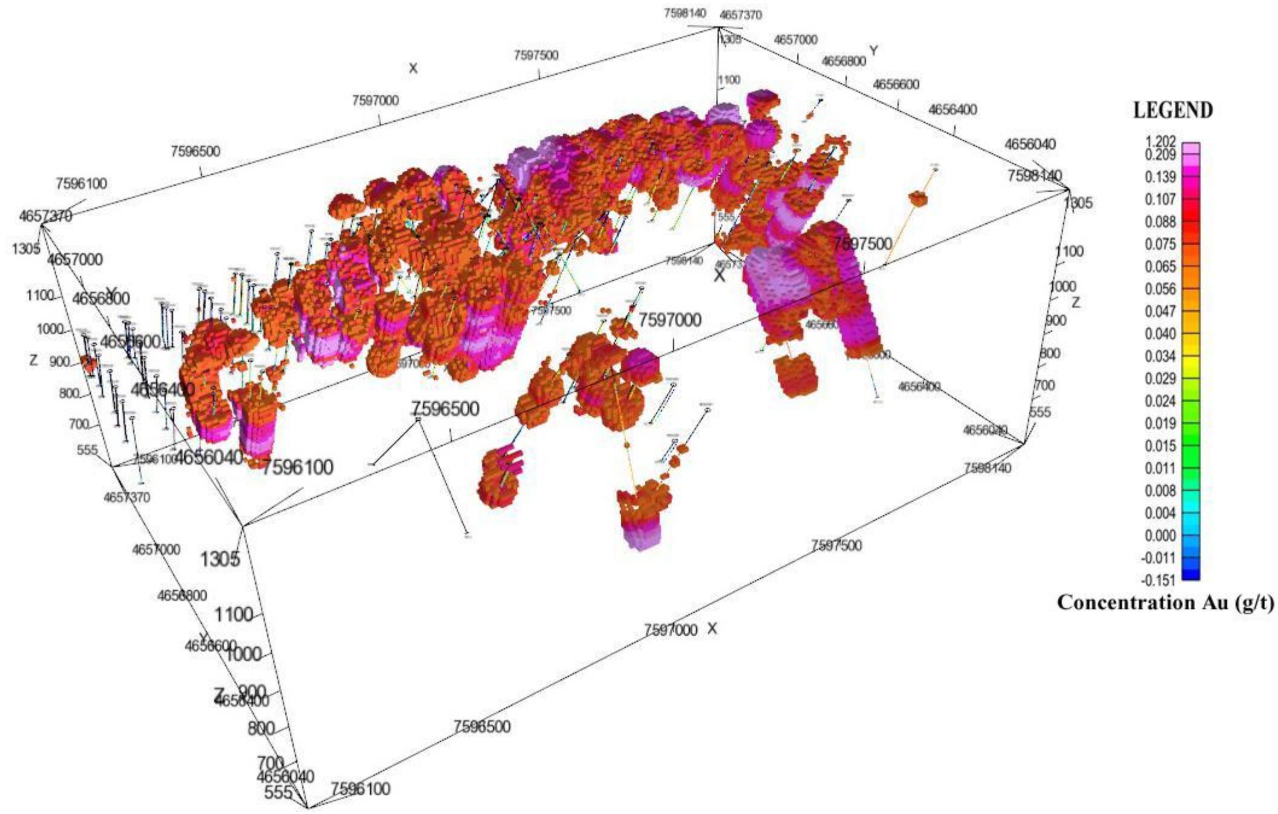
Following sound geological reasoning during the creation of the model, a considerable amount of knowledge regarding the mineralized area and the ore body was specifically updated (mineralization extending up to 300 m at depth); some new N-S striking and cross-cutting fault structures were interpreted (Figures 1, 2, 3 and 4), but further investigations are required to determine their metallogenetic relationship to any of the mineralization processes.

The most striking mineralization forms were determined, both for gold and copper, in southern-southeastern parts of the concession area towards so-called Maričanski Rid locality, as the southernmost position there.

We would like to stress out that the actual 3D model of the Plavica polymetallic deposit we can see that it strongly reflects the geochemical Au-Cu pattern already seen at the geochemical cross sections (Serafimovski et al., 2014). The present exploration at the Plavica deposit continues in the western and northwestern parts where exist positive field, structural-morphostructural, geological and geochemical indications for certain mineralization extension. Exploration continues with shallow exploration drill holes (in average up to 100 m).

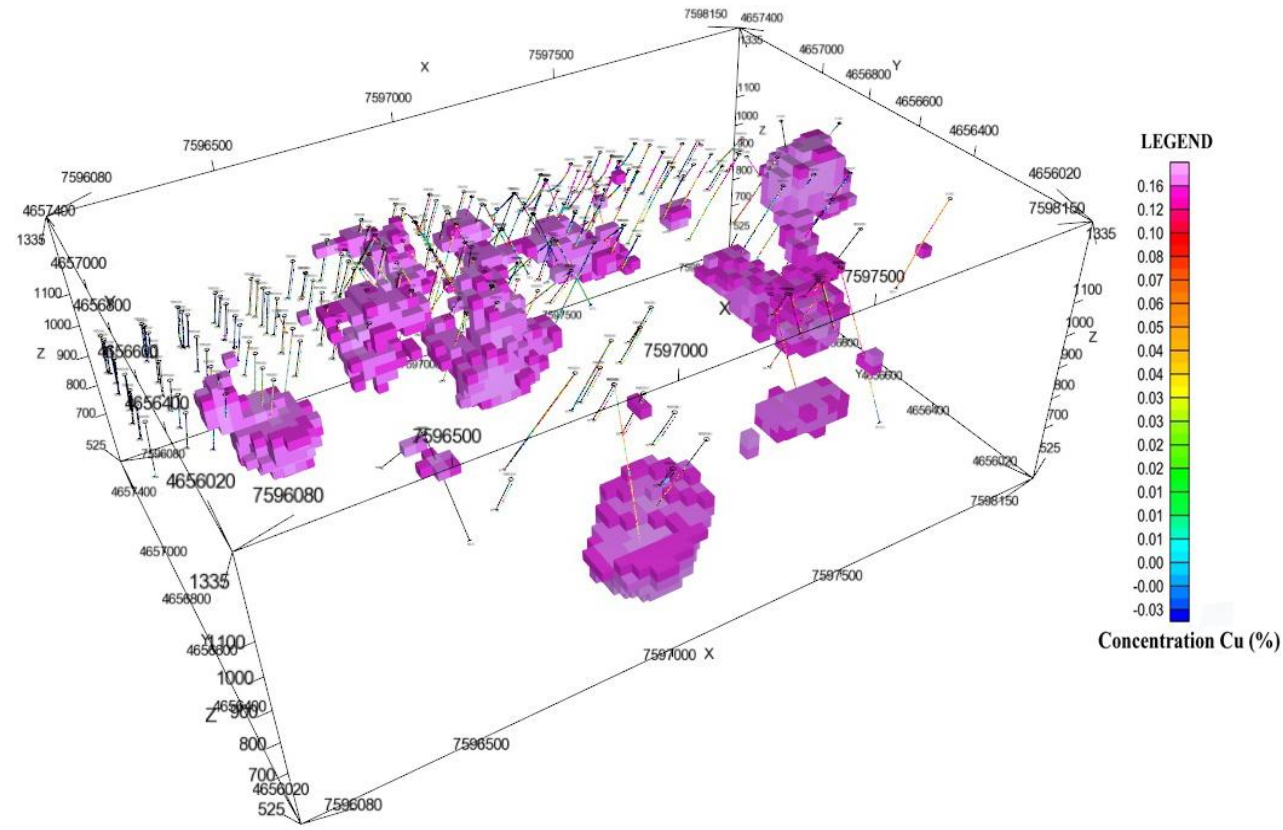


a)

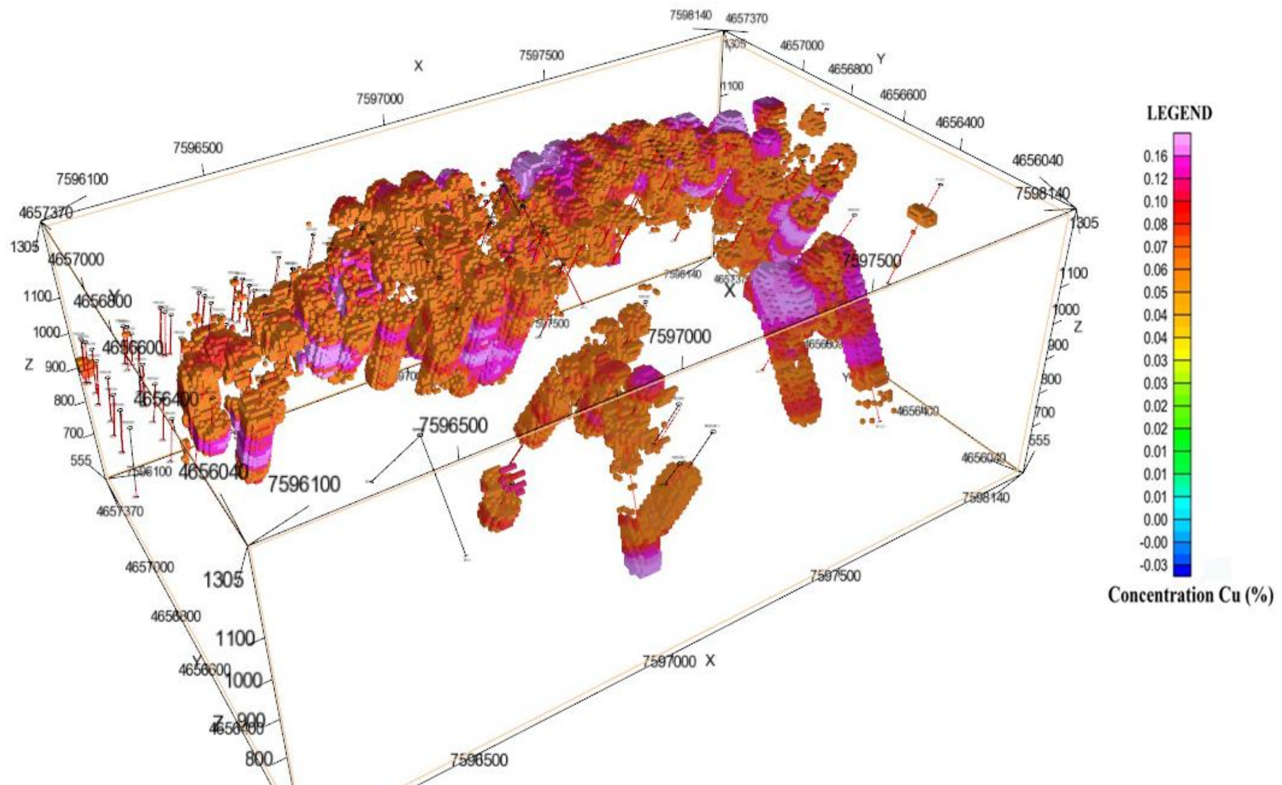


b)

Fig. 3. 3D model of the Plavica deposit, gold mineralization, resolution scale *a)* 30 m and *b)* 10 m.



a)



b)

Fig. 4. 3D model of the Plavica deposit, copper mineralization, precision scale *a)* 30 m and *b)* 10 m

CONCLUSION

Latest complex, geological, geochemical and geophysical explorations defined interesting gold and copper mineralization at the Plavica locality followed by significant presence of silver, zinc, lead and some other occasional metals. Direct implications of gold and copper geochemical anomalies, structural features and metallogenetic setting were confirmed by exploration drill holes, which confirmed that mainly gold and copper mineralizations are related to crushing zones, stockworks and disseminations as well as, quartz (massive and 'vuggy' silica) and quartz vein structures that directly reflect structural-tectonic setting of the area.

The gold-copper mineralization of polymetallic character with construction of the 3D model have revealed its isometric to lens/lensoid morphology, which swerves and distorts as depth increases.

It has been proved with the 3D model spatial position of gold and copper mineralization within the Plavica deposit between hypsometric levels 1305 and 600 m.

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Р е з и м е

3D МОДЕЛИРАЊЕ НА Au-Cu ПОЛИМЕТАЛИЧНОТО НАОЃАЛИШТЕ ПЛАВИЦА, РЕПУБЛИКА МАКЕДОНИЈА

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Клучни зборови: 3D модел; Плавица; злато, бакар; епитермално

Најновите истражувања и проучувања на епитермалното наоѓалиште на висока-сулфидизација Плавица покажаа значителен напредок во разбирањето на геологијата и дефинирањето на конкретното рудно тело. Резултатите од дупчотините направени од Генезис Ресурси Интернешнл ДООЕЛ Скопје, Република Македонија во 2011, 2012 и 2013 покажаа дека постојат: 51 метарски интервал со 3,9 g/t Au во зоната на оксидација, 65 метарски интервал со 3,1 g/t Au повторно во зоната на оксидација, како и 51 метарски интервал со 3,7 g/t Au, 2,8% Cu и 16 g/t Ag во сулфидната зона. За конструирањето на овој 3D модел беа користени сите 195 дупчотини направени од Генезис Ресурси Интернешнл. Дупчотините биле направени во периодот 2011–2013, во вкупна должина од 47295,8 m од кои 74 дупчотини биле направени со методата на дијамантско јадро и вкупна должина од 23908,3 m додека останатите 121 дупчотини биле изработени со методата на реверсна циркулација (РЦ) во вкупна должина од 23387,5 m. Со употреба на професионалниот сотфвер ArcGIS беа изработени 3D модели на рудното тело за злато и бакар, во соодветни резолуции од 30 m и 10 m, за секој елемент, а што ни го дефинираше простирањето на минерализацијата од 1305 m до 600 m хипсометриско ниво. Овие модели би требало да го подобрат нашето разбирање за минерализацијата и да ги надополнат геохемиските податоци за наоѓалиштето Плавица.