MAGMATIC-HYDROTHERMAL Cu-Au-(Mo-Pb-ZN-Ag) SYSTEMS IN THE SW-PART OF THE CARPATHO-BALKANIDES

R. JELENKOVIC[1] and T. SERAFIMOVSKI[2]

[1]*Faculty of Mining and Geology, Djusina 7, 11000 Belgrade, FR. Yugoslavia*
[2]*Faculty of Mining and Geology, Goce Delcev 89, 92000 Stip, R.Macedonia*

ABSTRACT: Magmatic-hydrothermal systems with polymetallic mineralizations are common in the SW parts of the Carpatho-Balkanides. Nevertheless, generaly they are most remarkable in three metallogenic units, that consists of igneous-volcanic rocks and ore mineralizations of different age. That are the Ridanj-Krepoljin and Bor-Donje Nevlje metallogenic zones, where ore systems connected with Cretaceous magmatism dominate, and metallogenic zone of Lece-Chalkidiki, where numerous volcano-intrusive complexes of Neogene age are located. With these volcanic complexes important Cu-Au polimetallic mineralization is connected.

Key words: Carpatho-Balkanides, magmatic-hydrothermal systems, metallogeny.

INTRODUCTION

Magmatic-hydrothermal Cu-Au-(Mo-Pb-Zn-Ag) systems in the East Serbian sector of the SW-part of Carpatho-Balkanides are located at the Ridanj-Krepoljin metallogenic zone and the Bor-Donje Nevlje metallogenic zone (Fig. 1). They were formed in the front of the Jurassic-Cretaceous oceanic slab, subducted from the Vardar zone beneath the Eurasian plate and differ with regard to the styles of mineralization and environments of deposition.

The second magmatic-hydrothermal polymetallic systems are related with the Lece-Chalkidiki metallogenic zone (Fig 2). These systems are formed in post-collision period, mainly at the contact between the Vardar zone and Serbo-Macedonian massif. As typical represents are: Plavica, Borov Dol, Lece-Kiseljak, Pontokerasia in Greece etc. On this worked numerous researchers, but for this paper of special interest are the papers presented by: Jankovic et al. 1995a, Jankovic et al. 1995b, Jankovic et al. 1996, Jankovic et al. 1997, Jelenkovic et al. 1997a, Jelenkovic et al. 1997b, Serafimovski et al. 1999, Serafimovski 1999, etc.

DISCUSION

The Ridanj-Krepoljin metallogenic zone is located along the western margin of the Carpatho-Balkan block. It can be traced from the area of Poiana Rusca north to Krepoljin the south for over 200 km. This major fracture is, at intervals, marked by hypabyssal granitoid intrusions, locally by the volcanics as well; its S-SE extension is possible for the next 200 km-up to the Rhodope block. The width of zone is mostly up to 1 km, but at local intervals-up to 2-10 km. A major fracture is, at intervals, accompanied

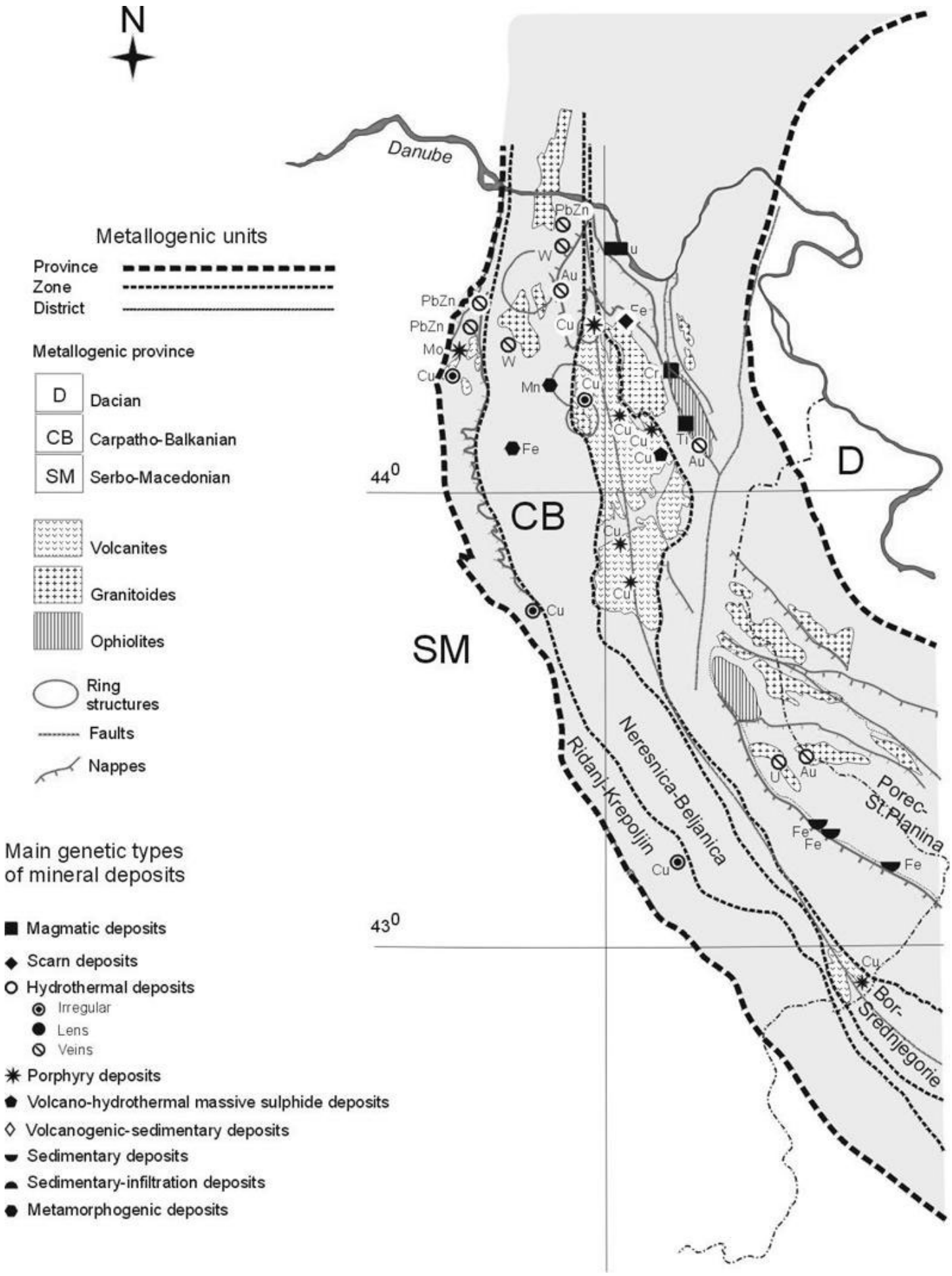

Fig. 1. *Carpatho-Balkanic metallogenic province - Eastern Serbia sector*

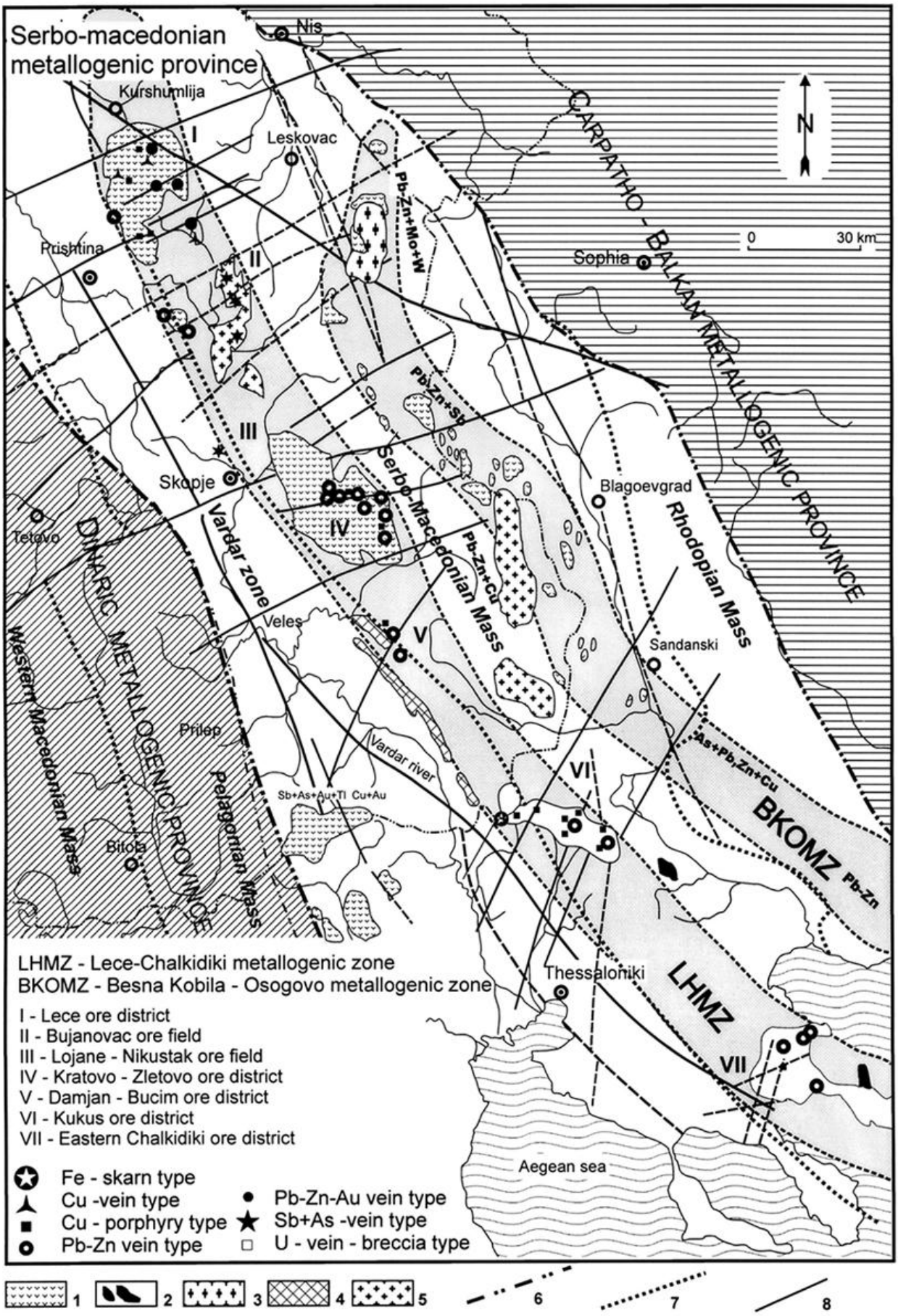

Fig. 2. Geotectonic and metallogenic position of the Lece-Chalkidiki zone (Serafimovski, 2000)

1. Neogene volcanics; 2. Tertiary intrusives; 3. Neogene granitoids; 4. Jurassic grano-diorites; 5. Hercynian granites; 6. Boundary of metallogenic provinces; 7. Boundary of metallogenic zones; 8. Lineaments.

by second-order fractures. A mineral zoning is displayed along Ridanj-Krepoljin metallogenic zone: in the area of Krepoljin dominates hydrothermal metasomatic Pb-Zn mineralization, accompanied by high concentration of Au/Ag, skarn Pb-Zn mineralization, and low temperature Sb-W mineralization. In its S-SE extension, the metallogenic zone is characterized by low temperature Cu mineralization in the Permian red sandstone, and, further southeastwards, by hydrothermal Ba and occasionally Hg mineralization.

This zoning is most likely due to erosional levels, or due to depth of magma emplacement.

The petrochemical characteristics, mode of occurrence, and age of igneous complexes at the Ridanj-Krepoljin metallogenic zone are not uniform. In the sector south of the Danube, two groups of igneous rocks are distinguished: the calc-alkaline, and the alkaline basaltic rocks. The calc-alkaline rocks are represented by subvolcanic intrusions of dacite and andesite, locally developed as pyroclastics, and minor quartz diorite porphyry. The absolute age of dacites and andesite in the area of Krepoljin (K-Ar determination) ranges from 72.6 my to 60.6 my, but mostly between 72.6 and 67.1 my.

The alkaline rocks occur sporadically as dykes of olivine-nephelite, limburgite, nephelinite, teschenite. Genesis of these rocks is still uncertain. The principal associations of elements at the Ridanj-Krepoljin metallogenic zone are identified in the ore deposits are classified as follows: (i) Cu, Pb-Zn, +/- Mo, Bi (skarn); (ii) Sb, W +/- Au (epithermal) and (iii) Cu-S (telethermal).

The Bor metallogenic zone is associated with a rift-greben environment, where volcano-intrusive complexes are developed, but the polygenic volcanics of central type development prevail. The ore deposits associate with the Upper Cretaceous +/- Paleocene multistage igneous complexes, are located within a narrow basin of rift-graben structure, filled by sedimentary and volcano-sedimentary rocks, mainlly of the Upper Cretaceous age. This basin is, at present, 0.5-10 km wide and over 100 km long. It can be traced from Majdanpek in the north, to the Donje Newvlje in the southeast. Copper and gold are the dominant metals, accompanied by iron (sulphide, oxide) and base-metals, molybdenum, sporadically PGE. The most prominent morphogenetic types of deposit are porphyry copper/molybdenum, volcanogenic cupriferous pyrite, massive base-metal sulphides, and hydrothermal veins, skarns of iron oxides, volcanogenic epithermal gold mineralization of high sulphidation type and exceptionally clasts of copper sulphide ore mechanically accumulated in the small sedimentary basin filled by pyroclastics. The ore deposits are groupped into several ore fields and districts, each characterized by some specific metalllogenic features.

This paper aims to briefly review of the magmatic-hydrothermal Cu-Au-(Mo-Pb-Zn-Ag) sistems in the SW-part of Carpatho-Balkanides, and their classification from the aspect of morphogenetical, structural and textural types of mineralizations.

In the third metallogenic unit (the Lece-Chalkidiki zone) are localized the magmatic-hydrothermal systems related with Tertiary magmatism. Some metallogenic features are given as follows. The ore mineralization in the Lece deposit is located within the silicified fracture zones. In addition to hydrothermal lead-zinc deposits, porphyry copper deposits discovered are also of interest.

The basic metallogenetic features of this type of deposits, similarly to those already described, are shown in Table 1.

Table 1. General features of the porphyry deposits in the Lece-Chalkidiki zone

Deposit	Kiseljak	Buchim	Borov Dol	Vathi	Pontokerasia	Skouries
Host rock	Andesite	Gneiss/ Andesite	Andesite	Brecciated rhyodacite	Rhyodacite/ Granosyenite	Granodiorite Porphyry
Parent igneous rock	Subvolcanic stock/andesite	Subvolcanic stock/andesite	Subvolcanic stock/andesite	Rhyodacite dyke/Subvolcanic	Subvolcanic stock/dyke.	Stock; Granod
Absolute age, my	12-23	25-28	24-28	30	32	29.6
Horizontal projection	0.24 km^2	0.25 km^2	0.15 km^2	150x700 m	300x400 m 200x400 m	100x200 m
Vertical extent	300-500 m	250 m	300 m	500 m		700 m
Hydrothermal alteration	Biot,Ser,Sil,Pyr, Arg,Ch,Ty,Di,Cd Cr	Pot,Biot,Ser,Sil, Ch	Pot,Biot,Ser,Sil, Arg,Ch,Ep,Ca	Pot,Biot,Ser,Sil	Ser,Sil,Ch,Ar,Pyr	Pot,Ser,Arg,Ch
Association of minerals	Cy,Py,Mgt,Mo, Au,T,Ga,Sp,E,Bi	Cy,Py,Mgt,Au, He,B,Bi,E,Ga, Sp,Te,Ag,Pd	Cy,Py,Mgt,He, Mo,Au,B,Sp	Cy,Py,B,E,Ga,Sp, Mgt,He	Cy,Py:Stockwork diss,Ga,Sp,Veins	Cy,Py,B,Au,Mgt Sp,Ga,T
Main Consti-tuents of ore	0.3 % Cu 0.3 ppm Au 1.0 ppm Ag 23 ppm Mo 4-10 % pyrite	0.3 % Cu 0.6 ppm Au 1.1 ppm Ag 13 ppm Mo 1-4 % pyrite Traces:Pd,Se,Te	0.3 % Cu 0.25 ppm Au 150 ppm Ag 24 ppm Mo 2 % pyrite	0.3 % Cu 0.15 ppm Au 0.35 ppm Ag 20 ppm Mo	0.3 % Cu 0.3 ppm Au 0.35 ppm Ag 20 ppm Mo	0.5 % Cu 0.7 ppm Au 2.5ppm Ag Traces: Pd,Te,Pt

Cy-chalcopyrite; Py-pyrite,B-bornite
Ga-galena; Sp-sphalerite; Mgt-magnetite
He-hematite; T-tetrahedrite; E-enargite
Bi-bismuthine; Au-native gold; Ag-silver min.

Pot-potassium; Biot-biotitization; Ser-sericitization; Sil-silification;
Agr-argilization; Ch-chloritization (proipilitic); Gr-greizenization;
(topaz,cassiterite, wolframite); Ep-epidotization; Ca-carbonatization
Pyr-pyritization; Ty-turmalinization; Di-diaspor; Cd-corundum

The table shows that they are low grade porphyry deposits of small horizontal and vertical range. Almost all porphyry deposits mentioned are in direct conection with subvolcanic dykes and stocks of the Tertiary igneous rocks.

CONCLUSIONS

Regional and local metallogenic explorations shows that in the terraines of the SW-parts of the Carpatho-Balkanides exists few complex magmatic-hydrothermal systems arranged in two metallogenic zones. Ridanj-Krepoljin zone and Bor-Donje Nevlje zone belongs to the first metalogenic zone with dominating Cu-pollymetalic mineralizations while Lece-Chalkidiki zone belongs to the second metallogenic zone with dominating Cu-Zn deposits.

REFERENCES

Jankovic, S., Jelenkovic, R., Serafimovski, T., 1995a: Geotectonic Settings and mettalogeny of the SW Margins of the Carpatho-Balkanides. III rd Annual Meeting, UNESCO-IGCP Proect 356, Athens.

Jankovic, S., Serafimovski, T., Aleksandrov, M., 1995b: The Besna Kobila-Osogovo Me- tallogenic zone. Geologica Macedonica, Vol. 9, No. 1, 39-50, Stip.

Jankovic, S., Serafimovski, T., Jelenkovic, R., 1996: Principal Metallogenic Districts at the Central Part of the Serbo-Macedonian Metalogenic Province.Proceeding of the Annual Meeting, UNESCO-IGCP Project 356, Vol. 1, 55-63, Sofija.

Jelenkovic, R., Jankovic, S., Serafimovski, T., 1997a: Prognosis Map of the Besna Kobila Mo-Pb-Zn-W-Metallogenic Zone. Symposium-Annual Meeting, Proceeding 159-167, Dojran.

Jankovic, S., Serafimovski, T., Jelenkovic, R., Cifliganec, V., 1997: Metallogeny of the Vardar zone and Serbo-Macedonian Mass. Symposium-Annual Meeting, Proceeding, 29-67, Dojran.

Jelenkovic, R., Jankovic, S., Serafimovski, T., 1997b: Prognosis Map of the Besna Kobila Mo-Pb-Zn-W-Metallogenic Zone. Symposium-Annual Meeting, Proceeding 159-167, Dojran.

Serafimovski, T., Dobrovolskaya, M. and Aleksandrov,M., 1999: The Genetic Model of the Large Pb-Zn Deposits Formation in Macedonia. EUG 10, Strasbourg, France.

Serafimovski, T., **1999:** The Lece-Chalkidiki metallogenic zone: Geotectonic setting and metallogenic features. Geologija 42, 159-161, Ljubljana.